THE

# CIVIL ENGINEER AND ARCHITECT'S JOURNAL,

INCORPORATED WITH

# The Architect.



VOLUME XVII.—1854.

LONDON:

R. GROOMBRIDGE AND SONS, 5, PATERNOSTER ROW; J. WEALE, HIGH HOLBORN; W. ROBERTSON, DUBLIN; SUTHERLAND, EDINBURGH; MATHIAS, PARIS; MUQUARDT, BRUSSELS; C. MONIER, MADRID; WILEY AND PUTNAM, NEW YORK.

PRINTED AND PUBLISHED BY WILLIAM LAXTON, AT 19, ARUNDEL STREET, STRAND, LONDON.

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## 1854

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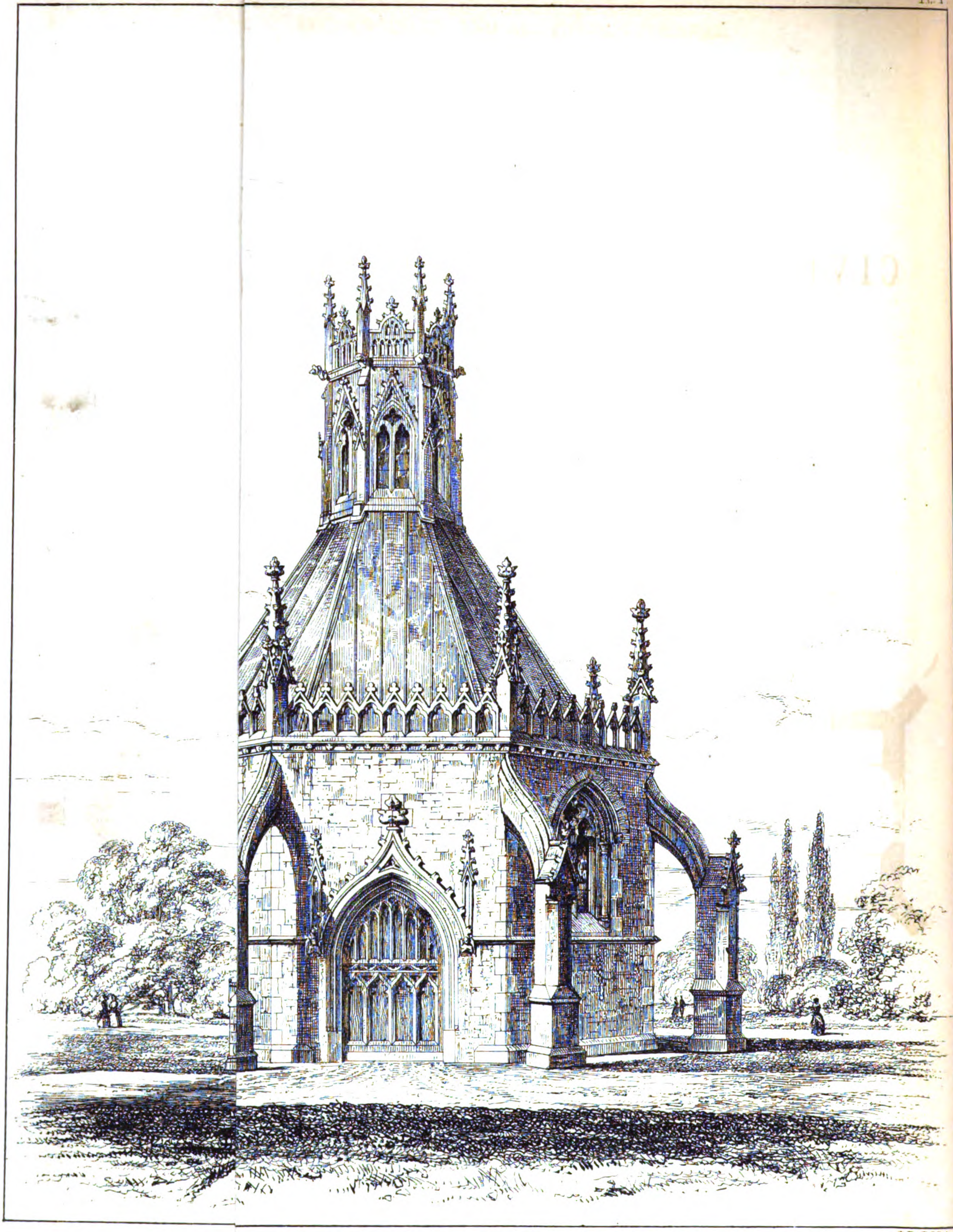


J.R. Jobbins.

DISSENTING CHAPEL.

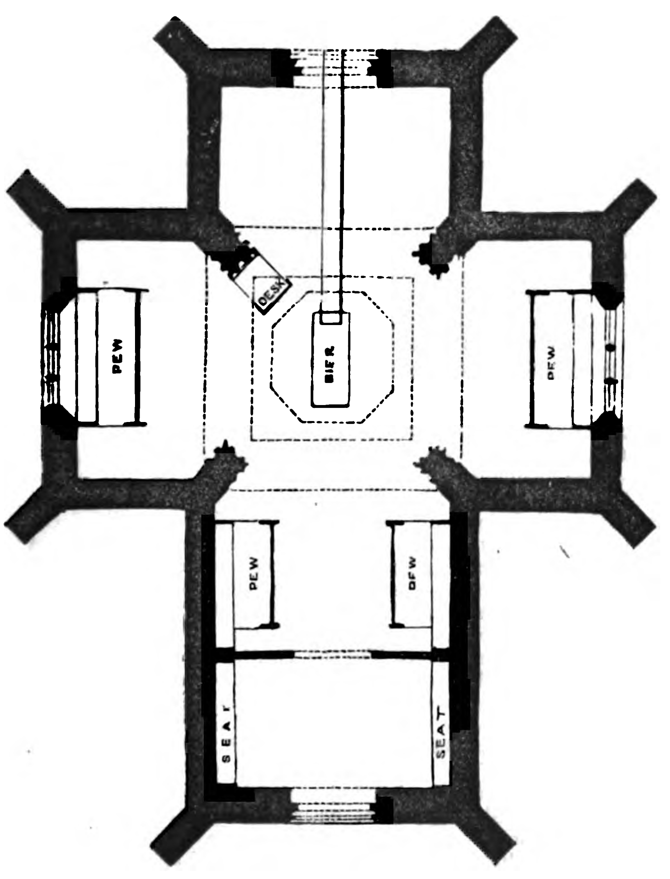
FINCHLEY.

THE

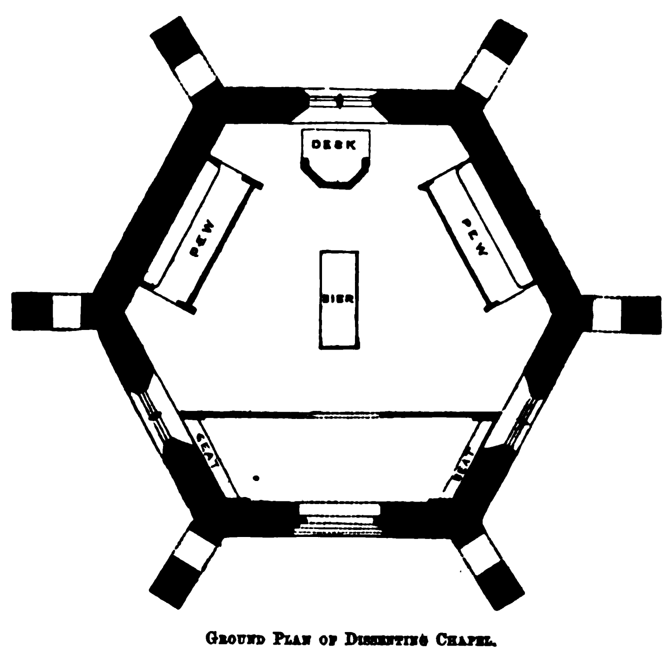
# CIVIL ENGINEER AND ARCHITECT'S JOURNAL.

## ST. PANCRAS' NEW EXTRAMURAL CEMETERY, AT FINCHLEY

(*With an Engraving, Plate* I.)




Ground Plan of Episcopal Chapel.




Ground Plan of Dissenting Chapel.

The site of ground upon which the cemetery is in course of formation is situate upon the high road to Barnet, near the village of Finchley, and known as the "Horse-Shoe Farm." It was purchased by the Burial Board of the Parish of St. Pancras, at the commencement of the present year, for the express purpose of a parochial cemetery, under the General Interments Act, 1851, and this is the first cemetery which has been purchased under the new Act. The whole area of the ground is 87½ acres, and finely undulating throughout.

As it was considered that about fifty acres would meet the requirements of the parish, a proposition was made and agreed to by the Board, that a certain portion should be inclosed for the burial ground, and the remainder let upon building leases; a negotiation was, however, subsequently opened, and is still pending, with the sister parish of St. Mary, Islington, to purchase for themselves a part of the ground, and thus convert eighty acres into one large extramural cemetery for their joint use, subject to certain details of division, to be afterwards decided by the respective Boards.

Messrs. Barnett and Birch, of 3, Verulam-buildings, Gray's-inn, had been previously selected by the Board of St. Pancras as their architects and surveyors; and upon consideration, the members constituting the same body for St. Mary, Islington, arrived at the conclusion that it would be preferable to have the whole laid out under the same superintendence. Messrs. Barnett and Birch are therefore now engaged by both parishes to carry out the whole of the joint undertaking.

The foundation-stone of the Episcopal Chapel was laid on the 24th November 1853, by the Rev. Thomas Dale, Canon of St. Paul's, Vicar of St. Pancras, and Chairman of the Burial Board. The Rev. Vicar, having completed the ceremony of laying the foundation-stone, addressed the assembly. After adverting to the ancient origin of cemeteries, from the time of Abraham downwards, and to that very natural feeling which existed in the human mind to see the rights of sepulture decently observed, he set before them the necessity which demanded the provision of this great parochial cemetery. One hundred years ago, or little more, St. Pancras was a rural parish. Its entire population at that time did not exceed the average number of the present inmates of the parochial workhouse, about 1200; it now reaches at least 175,000 and is believed to be increasing at the rate of 5000 annually. The number of deaths registered within the parish during the last year amounted to 3826; the number of interments in the parochial burying-ground to 1230; or nearly one-third; and about the same number must have taken place in certain grounds pertaining to other parishes within the limits of St. Pancras, together with Kensal-green and Highgate Cemeteries, for which returns are periodically made to him as vicar. There are yet six or seven burial-grounds in the parish of St. Pancras, parochial or non-conforming, from which no such return is made; when, therefore, all these grounds shall be closed, for which, in almost every instance, an Order in Council has been already issued, it can hardly be reckoned that fewer than 2000 bodies will be annually deposited in the parochial cemetery; and should deaths or funerals subsequently increase in the same ratio with the population, the ground now preparing for parochial interment—about fifty acres—would become completely occupied by the dead of three generations, or less than 100 years. By that time, however, the great metropolis will have extended its mighty arms even to the walls of this now rural cemetery; but by that time also, under discreet administration, a surplus revenue would have accumulated sufficient for the provision of another and more distant place of sepulture. With regard to the arrangements, first, it is intended that the cost of interments, whether to individual parishioners for their kindred, or to the parish for its poor, shall not, under any circumstances, exceed the existing scale, but, if practicable, fall below it. Secondly, that whatever difference may exist in the condition of the departed or the cost of the grave, there shall be none whatever in the religious service; it shall not be mutilated for the pauper as it may not be expanded for the peer. Thirdly, that means of conveyance shall be provided for the mourners at a moderate cost, each party having, as far as possible, its own carriage or compartment, when going to or returning from the place of sepulture. Fourthly, that the ground shall be so planted and so arranged as to preserve the solemnity and impressiveness which befit a place of christian burial, with such facilities afforded for its visitation during the hours of daylight as will enable all members of the parochial family to repair to the graves of their kindred and friends.

We give in this month's Number perspective views of the Episcopal and Dissenting Chapels, with ground plans of the same. It will be seen that both buildings are in the Decorated or Middle Pointed style. The height of the spire of the Episcopal Chapel will be nearly 100 feet; the division on plan at the west end is to be a carved open screen. The bier will move upon its axis, and be placed in the centre, immediately beneath the spire. The doorway at the east end was rendered necessary to provide a tramway and exit for a low carriage or bier on wheels, to transmit bodies for interment with greater facility to certain distant portions of the ground. This exit is formed with a vault-like aperture, and above it is a large triangulated rose window. The reading-desk is to be placed at the base of the north-east pier of the tower.

The Dissenting Chapel is situated at a considerable distance from the high road, at the extremity of the main carriage drive, and upon the brow of a fine hill. The valley in its front will be spanned by an arched viaduct the whole width of the road, which will form an attractive contrast to the natural undulations of the ground around it. The form of the chapel referred to is hexagonal, with a buttress at either angle, to receive the thrust from the stone ribs of the roof for supporting the lantern, which will also be of stone throughout. We propose, in a future Number, giving illustrations of the entrance lodges and gates, and other details connected with the undertaking.

## THE ARCHITECTURAL SKETCHES AT LILLE, ATTRIBUTED TO MICHAEL ANGELO.

By T. L. Donaldson.

[*Read at the Royal Institute of British Architects, Nov. 14th*, 1853.]

The Public Museum at Lille contains a most precious collection of 1200 original drawings, of which 197 are attributed to Michael Angelo, 3 to Leonardo di Vinci, 68 to Raphael, 13 to Masaccio, 6 to Andrea del Sarto, 9 to Bandinelli, 1 to Paola Veronese, 1 to Perugino, 1 to Gian. Bellino, 8 to Annibale Caracci, 2 to Coreggio, 17 to Carlo Dolci, 10 to Fra Bartolomeo, 15 to Francia, 8 to Guercino, 5 to Ghirlandajo, 3 to Giulio Romano, 1 to Palma, 5 to Parmegiano, 6 to Poussin, 2 to Tintoretto, 8 to Titian, 2 to Albert Dürer, 3 to Lucas de Leyde, 1 to Rembrandt, and 1 to David.

Many of these are apparently first sketches of pictures, which have since acquired the highest reputation, and show the gradual steps by which the great masters progressively improved the rude embryos of their first thoughts; and in order to compare the original ideas with the finished works there are engavings of the pictures as completed. Some are in pencil, others in black or red chalk, and several in bistre.—A most lovely model in wax, attributed to Raphael, of a female head the size of life coloured to nature, the contour, pose, and expression of which recall the perfection of Greek art, rivets the attention of every visitor. It is fractured in the neck, and evidently is of so frail a nature, that however anxious has been the desire to take a cast, the success seems too hazardous to justify the attempt. The drapery covering the bust and the pedestal are of terra-cotta of a later period. I consider this the gem of the collection.

To architects the most precious portion of the drawings is a series of 185 sketches of architectural subjects attributed to the pencil of Michael Angelo. They are now mounted in glazed frames, so arranged as to show both sides of the sheets, as they originally were in a sketch-book, and with drawings on both sides, the size 8 inches by 5 inches. They are generally drawn in bistre, and the plans tinted with a light shade of that colour. To some there are dimensions; others have the words *a dischretione e no e misurato*: sometimes the word *anticho* is added. They consist of plans, sections, details, and some few elevations of various ancient and modern buildings. Among the former are the arches of Titus, Septimus Severus, Janus, and Constantine, at Rome; of Augustus at Pola, in Istria; a plan and details of the Coliseum. Some seem to be plans of ædicula or tombs, like those then abounding in the Campagna; and I find No. 439 to be identical with the plan of Plate 24 of Montano's 'Scelta di varii Tempietti Antichi.' There is a sketch in pencil of the drum under the cupola of S. Peter's at Rome, as designed and executed by Michael Angelo, with the abutment piers and coupled engaged columns, instead of the continuous colonnade of previous designs, whether by Bramante or S. Gallo; and above are some loose lines in pencil indicating the dome, though not very definitely, and more like the Pantheon than S. Peter's. There are several drawings of the parts of the Church of S. Pietro in Montorio, which was designed and built by Bramante, the cotemporary of Michal Angelo and uncle of Raphael; and many sketches of the Baptistery at Florence, of the Lantern of S. Lorenzo, a plan of the Chiesa degli Angeli by Brunellischi, and other buildings in that city, and particularly of the Medicean Library, designed and almost entirely executed by Michael Angelo, but completed by Vasari. There are sketches of vases, arabesques, pulpits, and groups of trophies of ancient Roman armour. The commission having the care of these drawings have intimated that it is their intention to publish them.

During the short period of time that I was enabled to devote to the careful examination of the drawings I sketched off some of the plans, which I have since drawn out to about twice the size of the originals, in order to give an idea of the interesting character of the series. One of these, enlarged more than the others on account of its importance, gives a restoration of the Ruin in the Campo Vaccino, known as the Temple of Peace, or as our friend, Mr. Burgess, and other antiquaries call it, the Basilica of Constantine. It gave rise to some discussion, when Mr. Burgess favoured us during the last session with his instructive paper on the ancient Basilica and early Christian Temple. The sketch contains these original remarkable words upon it in Italian: (*"Questa una pianta d'una chiesa moderna no so di chi sia mano,"*) "This is a plan of a modern church by I know not what hand." Now the restoration of this ruin, as you are aware, has puzzled antiquarians and architects from the time of Serlio to that of Palladio, and down to the present period. Its name, its destination, and its plan have been a constant enigma; but it appears stranger still, if Michael Angelo be the author of these sketches, that he should copy the idea of another, call it a modern church, and say he knew not by what hand, when, from his constant residence at Rome, he must have had a thorough knowledge of the pile, whose three arches rise with majestic grandeur among the ruins of the Campo Vaccino, and his eye, familiar with the building, must have recognised at once an adaptation and not a *"chiesa moderna."* A curious coincidence is, that he himself, whether before the date of this sketch or after, it is impossible to say, converted a similar hall in the Baths of Diocletian, to the purposes of religious worship. The church, a majestic one from its size and simplicity, is known as the Madonna degli Angeli, and is interesting also to artists as containing the tombs of Carlo Maratti and Salvator Rosa; the grand hall is 198 feet long by 84 feet wide, independently of the end chapels, which give an additional length of 65 feet each, making a total length of 328 feet. These measurements were taken by Mr. Hardwick and myself, when we were together in Rome in 1818.

This sketch suggests many remarkable considerations. It omits the large lateral niche; it fills in small columns between the large arches of the nave, and thus decidedly separates the central nave from the side aisles; it adds small columns to the niches, as though each had a tabernacle, as in the Pantheon, a very probable conclusion. But the most important circumstance is the addition, at one end, of a noble portico of large proportions; where, from the time of Serlio to the present period, comprehending Palladio and Canina, the space is supposed to be occupied by a paltry arcade. As such a feature is irreconcileable with the broad treatment of the rest of the edifice, and considering the arcade to be a construction of more recent times, it seems more consistent with the true spirit of the original design to give it a more dignified façade than that of Palladio or Canina, so as to be accordant with its size and disposition, maintaining its importance with the Temple of Venus and Juno immediately adjacent, and the other magnificent buildings of the Roman Forum, to which it is contiguous.

Our friend, Mons. Hittorf, to whom I sent a copy of this sketch, has called my attention to the similarity between the plan of this portico and that of a portico to S. Peter's attributed to Michael Angelo; they are placed side by side on one of the illustrations now exhibited, the only difference consisting in the number of the columns,—the one being for a tetrastyle, the other for a hexastyle portico, and the projection of the porticoes being respectively two and three intercolumniations. Our distinguished Honorary and Corresponding Fellow calls attention to another suggestion presented by the plan, which forcibly revives the early impression upon his mind, that the primitive plan of S. Peter's at Rome, as designed by Bramante, consisting of a simple Greek cross, and divested of its superfluous accessories, would seem to have been suggested by the plan of this ruin, with which in its main lines and features it palpably corresponds.

Such are some of the speculations which arise from the contemplation of this plan, and the startling words—*"chiesa moderna no so di chi sia mano."*

I shall not perplex you nor myself by any lengthened speculations upon the real character and destination of this edifice. Its plan is wholly at variance with the type presented in any known temple of the Greeks or Romans; hence the name of Temple of Peace seems inappropriate. Its plan is no less discordant from the precepts of Vitruvius, or any other basilica in ancient Rome, hence the term Basilica of Constantine would remove it from the usual basilican canon; and experience does not teach us that the Romans of later times departed very materially or radically from established previous types. But its vicinity to the Domus Aurea of Nero makes me inclined to consider it as a vestibule to that noble palace, partially saved from the conflagration, restored, added to by Maxentius, and possibly christened with a new name in periods much subsequent to its original erection—And now *requiescat in pace.*

The next sketch, to which I invite attention, is that of the plan of the vestibule to the Medicean Library at Florence. Those who have visited that building will remember the vestibule and its strangely-planned flight of steps leading up into the library; and they will recal the columns sunk in the walls, and other grotesque mixtures of heterogenous forms in the details, which fully bear out what Vasari says of Michael Angelo,[1] and who thinks to praise the master for having "composed a decoration of" what he calls "a richer and more varied character than had ever before been adopted, either by ancient or modern masters." The beautiful cornices," says he, "the capitals, the bases, the doors, the niches, were all very different from those in common use, and from what was considered *measure, rule, and order by Vitruvius* and the ancients; to whose rules *he would not restrict himself.* But this boldness on his part has encouraged other artists to an injudicious imitation, and new fancies are continually seen, many of which belong to *'grottesche,'* rather than to the wholesome rules of ornamentation. Artists," continues Vasari, "are nevertheless under great obligations to Michelagnolo, seeing that he has thus broken the barriers and chains whereby they were perpetually compelled to walk in a beaten path, while he still more effectually completed this liberation, and made known his own views in the Library of San Lorenzo, erected at the same place. The admirable distribution of the windows, the construction of the ceiling, and the fine entrance of the vestibule, can never sufficiently be extolled. Boldness and grace are in the work as a whole, and in every part: in the cornices, the corbels the niches for statues, the commodious staircase, and its fanciful divisions,—in all the building, at a word, which is so unlike the common fashion of treatment, that every one stands amazed at the sight thereof."

The Medicean family having collected a vast quantity of very fine manuscripts of the classic authors, from the Greeks who had been driven from Constantinople, and from other sources, were anxious to provide a receptacle worthy so rich a treasure.[2] Clement VII., one of the Medicean Popes, was desirous of establishing memorials to his fame in sculpture, painting, and architecture, as Leo and his other predecessors had done. This was about 1625, and Michael Angelo was summoned to Florence to design the library, to be called that of San Lorenzo, with a new sacristy to the church, wherein the Pope proposed to erect the marble tombs of his forefathers,[3] two to inclose the remains of the fathers of the two Popes, Lorenzo the elder, and Giuliano his brother, with those of Giuliano Duke of Nemours, the brother of Leo, and of Lorenzo Duke of Urbino, his nephew.

Eight years afterwards, in 1533, Pope Clement died[4], when the works then proceeding at the library and sacristy in Florence, which, notwithstanding all the efforts made, were not yet finished, were at once laid aside. Towards the middle of 1555, during the time of Paul III., "Duke Cosinio had sent Tribolo to Rome to try if he could persuade Michelagnolo to return to Florence there to finish the sacristy of San Lorenzo; but the master had excused himself, saying, that he was become old, might no longer endure the fatigue of labour, and could not leave Rome. Tribolo then inquired as to the steps for the library of San Lorenzo, for which Michelagnolo had caused many of the stones to be prepared, but for which no model nor any certain indication of the form in which they were to be constructed, could be found. It is true, that there were some few sketches of a pavement and other things in terra, yet the correct and final design of the work could not be ascertained. But not all the entreaties of Tribolo, although he brought in the name of the Duke, could move Michelagnolo to say more than that he did not remember. The Duke then commanded Vasari to write to the master, since it was hoped that for the love of him, Michelagnolo would perhaps say something, which might enable them to bring the work to conclusion. Vasari wrote to him accordingly as the Duke desired, adding, that of all which had to be done Vasari was to be the director, and would do everything with the utmost fidelity, taking care of every minutiæ, as of a work of his own. To this Michelagnolo replied by sending the plans for the work in a letter, written by his own hand, on the 28th Sept. 1555:

'Messer Giorgio, my dear friend—About the staircase, whereof there has been so much said, believe me, that if I could remember how I had arranged it, I should not

1 Vasari's Lives, translated by Mrs. Foster, vol. v. p. 272.
2 Page 271. 3 Page 274. 4 Page 282.

2*

require so many entreaties. There is a certain stair, that comes into my thoughts like a dream; but I do not think it is exactly the one which I had planned at that time, seeing that it appears to be but a clumsy affair; I will describe it for you nevertheless. I took a number of oval boxes, each about one palm deep, but not of equal length and breadth. The first and largest I placed on the pavement at such distance from the wall of the door, as seemed to be required by the greater or lesser degree of steepness you may wish to give to the stair. Over this was placed another, smaller in all directions, and leaving sufficient room on that beneath for the foot to rest on in ascending; thus diminishing each step as it gradually retires towards the door; the uppermost step being exactly of the width required for the door itself. This part of the oval steps must have two wings, one right, the other left. The steps of the wings to rise by similar degrees, but not to be oval in form. The ascent by the middle flight, from the centre to the upper part, shall be for the Signore; the turn of the wings must be towards the wall. But from the centre downwards to the pavement, they shall be kept at the distance of about three palms, in such sort that the basement of the vestibule shall not be infringed upon in any part. What I am writing is a thing to be laughed at, but I know well that you will find something suitable to your purpose."[5]

In a brief conversation on the subject, which I had with Monsieur Benvignat, the architect of Lille, he gave it as his opinion, that the sketch exhibited in the Wicar collection is the original idea of Michael Angelo; that he had lost the book, and forgotten this his first conception. But the sketch is equally at variance with the master's letter just quoted, and the staircase as executed. The sketch presents an oval series of steps, half without and half within the door of the library; but the number would not have accomplished half the height to which it was necessary to rise, and although oval like the boxes alluded to by Michael Angelo, there are no side steps.

So restricted is the vestibule, that the intrusion upon the space of the floor, by the capricious form given to the flight as executed, leaves very inadequate room for the landing at the bottom of the stairs; and if any method could have been devised of gaining space by making some of the steps rise within the doorway, much convenience would have been gained. I am inclined therefore to think that this sketch is a slight idea of Vasari's founded upon some vague rumour of Michael Angelo's arrangement, to try how it could be carried into execution, before he had received the master's formal instructions.

This brings us to the consideration of the important question, who was the real author of these sketches? My own impression is, that *the whole book* may be attributed to Vasari himself—that all the sketches of the Library, of the Cupolino of the Sepulchral Chapel, and of the other details of Michael Angelo's work, were taken for his own guidance, or for the purpose of sending off copies to the master, to enable him to give the proper instructions to direct Vasari's proceedings in the completion of the buildings confided to his care.

The sketches generally are executed with a certain ready freedom of hand and no great care; but some are drawn with much delicacy and with considerable precision and minuteness of form. Hardly more than two or three evince that bold and vigorous freedom of treatment, which we are accustomed to consider as characteristic of the Maestro, as Vasari repeatedly calls him. One circumstance particularly struck me, and that was the numerous sketches of the circular chapel built in the cloister court of S. Pietro a Montorio, by Bramante. This building excited vast admiration at the time, and Serlio himself gives the plans, elevations and sections of it in his work next to those of the cupola of S. Peter's, and among the numerous illustrations of ancient buildings, and Palladio also gives it among his ancient edifices. Other writers of the time mention it with unqualified praise. It would therefore be no wonder if Vasari, who was employed upon designs and models for tombs at S. Pietro a Montorio by order of Julius III., should have sketched parts and kept a record of such details. But that Michael Angelo, who despised the trammels of *ancient art*, should condescend to the task of minutely drawing the work of a cotemporary, and that cotemporary no friend of his, but the uncle and supporter of his rival Raphael, and one, who crossed him in his great work for the tomb of Julius, seems beyond probability, however noble were many impulses of Michael Angelo's generous nature. I am given to understand, that many French artists, who have visited the Wicar collection, concur in my opinion as to the propriety of not attributing this collection of sketches to Michael Angelo; and a distinguished member of the French Institute, a great amateur and connoisseur, assures my friend Hittorff, that he had traced the writing on some of these drawings, and that it did not at all accord with that of the great master. I am therefore confirmed in the conviction, that these architectural sketches are not the production of Michael Angelo.

I shall now notice a letter from Francis I. to Michael Angelo; but before I put you in possession of this most precious of the treasures of the Wicar collection, it is necessary for me to give a few particulars of one to whom it refers, and which I shall do by quoting another passage or two from Vasari. Francesco Primaticcio was sent by the Duke Frederigo of Mantua to France, at the request of Francis I., who, having heard of the decorations with which he was adorning the Palazzo del T, desired to have an able artist to execute like works for him at Fontainebleau, and elsewhere.[6] Primaticcio, according to Vasari, was the first to paint frescoes of any account for the French king, and we all know how admirably he succeeded in the great and superb ball-room at Fontainebleau:

"King Francis, being much pleased with the conduct and proceedings of Primaticcio, sent him in 1540 to Rome, he having put the wish, according to Benvenuto Cellini,[7] into that monarch's head to possess antiques. He purchased several antiques in marble, and served the king so diligently, that what with heads, trunks, and entire figures, he bought in no long time 125 pieces. At the same time Primaticcio caused Barozzi da Vignola and others to copy the bronze horse of the Capitol, the greater part of the relievi of the column, (probably Trajan's,) the statue of Commodus, the Venus, Laocoon, the Tiber, the Nile, and the statue of Cleopatra, which are in the Belvedere, and all which were to be cast in bronze".... "Being recalled to Paris he returned immediately. But, before attending to any other occupation, Primaticcio caused the greater parts of those antiques to be cast, when all succeeded so well, that they might be taken for veritable works of antiquity, as may still be seen" says Vasari "in the Queen's garden at Fontainbleau, where they were placed to the great satisfaction of King Francis, who may be said to have there made another Rome".... "The king, perceiving that he had been well served during the eight years, that Primaticcio had been with him, appointed the painter to be one of his Chamberlains. And shortly after (in 1544 that is to say) his Majesty made him Abbot of S. Martin (at Troyes.)"

The document, which rendered necessary these preliminary remarks, is as follows:—

Sr. Michaelangelo pourceque jay grant desir davoir quelques besognes de vre ouvrage jay donne charge a labbe de Sainct Martin de Troyes pnt porteur que jenvoye pardela den recouvrir vous priant si vous aves quelques choses excellentes faictes a son arrivee les luy voulloir bailler en les vous bien payant ainsique je luy ay donne charge Et davantaige voulloir estre contant pour lamour de moy quil molle le christ de la Minerve[8] et la nre dame de la febre[9] affinque jen puisse aorner lune de mes chappelles comme de chose que lon ma asseure estre des plus exquises et excellentes en vre art. Priant dieu Sr. Michelango [sic] quil vous ayt en sagarde. Escript a Sainct germain en Laye le VIII. jour de feurier mvxlv.

FRANCOYS.

No. 199. DELAUBESPINE.

This letter proves that Primaticcio must have made a second visit to Italy for the purpose of collecting more works of art, and its truly princely sentiments evince the taste, the liberality, and high-minded generosity of a real lover of the fine arts. How fortunate has France been for three centuries in having princes who felt that the fine arts can contribute essentially to the refinement, the happiness, and prosperity of a nation. This spirit has endowed Fontainebleau, Paris, and Versailles with the masterly productions of the greatest minds in Italy and France. The lower orders have their enjoyments in common with the princes, the nobles, and gentry of the land; and they grow up imbued with the love of that art, which is so mixed up with their holiday enjoyments, that it becomes a necessity, as it were, from their being used to it from their earliest years; and they are thus unconsciously educated by the contemplation of the finest works. How far are we in this respect behind our neighbours. The gardens of the Tuilleries have no parallel with our royal residence of Buckingham Palace; and Fontainebleau puts to shame the courts and terraces, gardens and walks of Windsor Castle, which contain hardly a single statue, group, or fountain, or other art accessories of any consequence, and appear cold and meagre, and poverty stricken from the want of such accompaniments. So niggardly and deficient in art feeling have those authorities been, who have hitherto had to provide for the palaces of our Sovereigns, and the places of public resort for the people. Often was Francis I. thwarted by his ministers in his munificent desire to promote the fine arts, but he was not to be turned away from an object which he knew would gratify his people and ennoble his country. And well has this noble spirit been rewarded for his early enlightened cultivation of the fine arts, for his example has been followed by the continued munificence of succeeding monarchs and ministers, which has produced that superiority in the art productions of their manufactures, which enables them to compete so

[5] Gaye in his Carteggio, makes it doubtful whether Vasari finished these steps or not; and a Florentine commentator says, "Although Michael Angelo had left the steps, the balustrade, and many other parts of this work in a state of preparation, it is manifest that Vasari did not succeed in comprehending the master's wish. He constructed a magnificent flight of steps, without doubt, but not that intended by Michael Angelo."—See *Ruggieri, Studio d'Architettura Civile*; also *Rossi, Libreria Medicea Laurenziana.*

[6] Vasari's Lives, translated by Mrs. Forster, vol. v. p. 371.

[7] Vita, vol. ii. p. 131, Ediz. di Milano, 1811, 8vo.

[8] This celebrated statue is still preserved in the Church of the Minerva, near the Pantheon, Rome.

[9] This statue was, according to Vasari, executed for the Cardinale di S. Dionigi to put in old S. Peter's, in the Chapel of the Virgin Mary of the Fever. I have made ineffectual inquiries to ascertain precisely where this statue is. Mons. Hittorff thinks it the Madonna della Pietà, the cast of which was in one of the chapels of Fontainebleau up to the time of the Revolution. Probably it may be the Pietà of S. Peter's, at Rome, re-named after the time of Vasari.

successfully with the mere mechanical skill and industry of other nations.

Michael Angelo has been the main topic to which I have been so bold as to claim your attention; and surely his position as an artist claims for him the respect and admiration of every painter, sculptor and architect. And although he was a great innovator in architecture, and introduced a license which was most pernicious to the art, yet we cannot but recollect that we owe to him the simplicity of design, to which he reduced the cupola and other decorations of S. Peter's, which had been sadly corrupted by the immediate successors of Bramante, whose original conception had been lost. Vasari mentions[10] that "while Antonio San Gallo lived, Pope Paul had permitted him to continue the building of the Farnese Palace. But the upper cornice on the outside was still wanting; and his Holiness now desired that this should be added by Michael Angelo, after his own design and under his direction. The master, therefore, not willing to disoblige the Pope, who esteemed and favoured him so much, made a model in wood, seven braccia long (13½ feet), and of the exact size which the cornice was to be. This he caused to be fixed on one of the angles of the palace, that the effect might be seen, when, as the Pontiff and all Rome with him were much pleased therewith, it was put in execution, proving to be the most beautiful and varied cornice ever erected, either by the ancients or moderns[11]. He continued the great court also, constructing two ranges of columns over those first erected, with the most beautiful windows, and a great variety of rich ornaments, ending with the great cornice; all of these works being so beautiful, that this court by the labour of Michael Angelo has now become the finest of all Europe."

You will doubtless remember the beautiful picture by Haghe in the New Water Colour Exhibition of the year 1848,[12] representing Michael Angelo, himself an old man, nursing by his midnight lamp his faithful servant Urbino, who was ill; his master sleeping at night in his clothes beside him, the better to watch for his comforts. Vasari gives the following touching letter written to him by Michael Angelo on this occasion:—

"My dear Messer Giorgio—I can but ill write at this time, yet to reply to your letter I will try to say something. You know that Urbino is dead, and herein have I received a great mercy from God, but to my heavy grief and infinite loss. The mercy is this, that whereas in his life he has kept me living, so in his death he hath taught me to die, not only without regret, but with the desire to depart. I have had him twenty-six years, have ever found him singularly faithful, and now, that I have made him rich, and hoped to have in him the staff and support of my old age, he has disappeared from my sight, nor have I now left any other hope, than that of rejoining him in paradise. But of this God has given me a foretaste, in the most blessed death that he has died: his own departure did not grieve him (so much) as did the leaving me in this treacherous world with so many troubles. Truly is the best part of my being now gone with him, nor is anything now left me, except an infinite sorrow. And herewith I bid you farewell."

I have been insensibly led, by the interest which attaches to the talents and character of this great man, to depart from the immediate subject of my paper, and to conclude my remarks by an allusion to his works at the Farnese, and by the contemplation for a moment of the affecting incident, which lays open the inmost soul of Michael Angelo, and shows him with the tenderest regard as a kind master, and the finest feelings of the most pious resignation in the contemplation of his own not far distant end, —as exemplary as a Christian as he had been eminent and admirable as an artist. But I will now conclude, and trust, that I may not be considered too presumptuous in so boldly offering my opinion as to the authorship of these architectural sketches. Whosesoever they may be, whether Michael Angelo's, or Vasari's, or any other artist's, they are extremely curious and interesting in the history of our art. I hope that none of my professional brethren, who have not yet seen these drawings, will now pass through Lille without visiting this fine collection. They will then, in addition to the delight they will experience in seeing the masterly thought-renderings of other great men, be enabled to judge for themselves and to decide, whether I am wrong or right in hesitating to attribute to the mighty Florentine these architectural sketches, which well deserve the minutest attention from every lover of architecture.

*Discussion.*—Mr. Tite stated, that it happened to him, in the summer of last year, to be detained in Lille for five hours on a wet afternoon, waiting for the train to Calais, when he was directed to the Musée, in order to pass a portion of that time. Proceeding to the rather magnificent Hotel de Ville, described by Mr. Donaldson, of which he had never heard before, he was astonished to find, not only the marvellous collection of drawings referred to, but an extensive and interesting museum, illustrative of art, antiquity, and ethnology. So easily might Lille be visited, and so well did the collection deserve further inquiry, that he strongly recommended his hearers to go there. In reference to the architectural portion of the drawings, he was sorry to find that Mr. Donaldson considered they were not, as he (Mr. Tite) had fondly hoped, the work of Michael Angelo. Mr. Donaldson had brought forward strong reasons in support of his opinion; and to his judgment and knowledge of the subject he must at once defer. He had himself copied from one of the drawings the name of Michael Angelo, which was clearly written upon it; and it would be very easy to compare that with his undoubted autograph, so as to settle the question. One of the largest of the drawings appeared to him to be the first sketch of the great architect for the dome of S. Peter's with the double cupola. He was informed at Lille that M. Wicar was employed by Napoleon Bonaparte in Italy to collect works of art, and that in doing so he helped himself to these drawings, which he bequeathed on his decease to his native city. In addition to the interesting letter of Francis I., which Mr. Donaldson had read, he begged to read the following from Bonaparte to M. Wicar, which was exhibited with the drawings; and which, notwithstanding certain peculiarities of diction, he had no doubt was dictated by Bonaparte himself, in 1796, from Milan:—

*Armee d'Italie.* *Republique Francaise.*
*Liberte Egalite.*
Au Quartier General.
Milan le 22 Prarial.
An 4 de la Republique—une et indivisible.
Bonaparte General en Chef de l'Armée d'Italie.

Au M. Wicart, peintre à Florence.

J'ai reçu votre lettre du 6 Prarial. Je 'ny ai point reçu les esquisses que vous m' vez annonciez.

Je vous engage a continuer d'occuper votre talent d'objets dignes de l'homme qui pense.

Je serai toujours fort aise de pouvoir de vous être bon a quelque chose.

Bonaparte.

The sketches generally were singularly curious and beautiful; and he had been so much struck with them that he had contemplated interesting the architects of France with a view to have them published in lithography, which might be easily and cheaply done; and he would suggest to the Council that they might be able to promote this object. Whoever was the author of the sketches, he thought they might prove very useful in restoring the magnificence of ancient Rome. With regard to the Basilica of Constantine, he should be very glad to believe that there had been such a portico as the drawing referred to by Mr. Donaldson indicated. He believed, however, that both Palladio and Canina (the latter especially) were quite inclined to include a portico in their restorations of that building; but that it would be found that there could not have been such a portico, unless, indeed, the Via Sacra could be supposed to have passed within it. The Institute were under the greatest obligation to Mr. Donaldson for the attention he had given to the illustration of these works, which were undoubtedly the production of some very clever man, if not of the great maestro himself.

Mr. Donaldson said, that he had intimated to M. Benvignat, who was a member of the Commission having the care of these drawings, that he was sure the Institute would be much pleased to have tracings of them; but that gentleman believed this would not be possible, inasmuch as the Commission had the intention of publishing them very shortly. It would, however, be desirable to express the interest which this Institute felt in the matter, with the view of promoting that result.

Mr. Bell, M.P., bore testimony to the extreme value and interest of the drawings, both in an architectural and artistic point of view. He had himself intended to revisit them, and prepared a paper on the subject; but he rejoiced, that in directing Mr. Donaldson's attention to them, he had insured its being much more ably done.

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*Newcastle Docks.*—The plans and surveys for these docks have been made by Mr. W. A. Brooke, C.E., and Mr. John Dobson, architect, of Newcastle, and been deposited agreeably to standing orders. A dock of about twenty acres, with suitable basin, tidal basin, and locks, is projected, with a depth of 23 feet at the outer lock sills, and a width of 52 feet in the locks, for the admission of large steamers. A railway of about half-a-mile will effect a junction with the York, Newcastle, and Berwick Railway.

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[10] Vasari's Lives, translated by Mrs. Forster, vol. v. pp. 296-7.

[11] The cornice to the Strozzi Palace at Florence, must have suggested to Michael Angelo the grandiose character of that of the Farnese of Rome.

[12] See *Illustrated London News*, 22nd July 1848.

## GREAT EXHIBITION SURPLUS APPROPRIATION.*

The surplus funds of the Great Exhibition have, with a government grant, been applied to the purchase of an extensive site at Kensington, with the understanding that it is to be appropriated to buildings for the promotion of science and art. As yet no definite scheme for effecting these objects has met with acceptance. The formation of an industrial museum does not at present offer the means of occupying the area, nor does it present such attractions as to be likely to obtain a very large grant of public money. The erection of a palace of science, or a palace of the institutes, in which all the learned institutions should be united and provided with theatres, libraries, and museums, has met with little support from the members of the institutions, who prefer central situations to location in a remote part of the enormous metropolis. The removal of the National Gallery, likewise supported by residents at Kensington, and by persons keeping carriages, is too evidently suited to the convenience of the aristocratic classes, and so opposed to the convenience of the great body of the population, that it has been denounced instead of being allowed, as hoped by the promoters, to be carried into effect with little resistance. If the deportation of the scientific institutions to Kensington is opposed to the convenience of individuals in easy circumstances, and has met with determined resistance, the monstrous proposition of withdrawing an establishment especially devoted to popular uses, from the reach of the population, justly deserves severe reprobation. The National Gallery, while it is designed to assist in the education of artists, was certainly never meant for the delectation of the aristocracy, who have more valuable galleries of their own, from which the public are excluded. It was because the treasures of art in this metropolis, among the richest in the world, are—in a mean and narrow-minded spirit, and in opposition to the moral obligations incumbent on the owners—withheld from the public gaze, and because the English public, deprived of the opportunities of cultivation, are behind the standard of our continental rivals, that the National Gallery was established as a free public institution for the cultivation of the taste of the masses. If, from gross mismanagement the space provided for this collection is now found inadequate, that is no reason for its removal to Kensington, beyond the reach of the artizans of the east and south, and of their wives and children. Were it proposed to be moved nearer to the abodes of those classes, that would be a proposition more in conformity with the spirit of the institution than to move it to a remote part of those very districts from which the artizans are most removed. The same objection exists to the establishment there of a great industrial museum. The site is about as appropriate as Bethnal-green for the courts of law, or Battersea for the Bank of England.

In all schemes as to public buildings there is now this circumstance to be borne in mind—that the conditions of sites in the metropolis have been altogether altered by the abolition of the window duties. An adventitious and artificial regulation caused an enormous space to be covered over with small houses, in opposition to the natural habits of the population; but, now that the obstacles have been removed, large buildings have been erected in the heart of the metropolis, either as offices or as residences in chambers, suites of rooms, or flats; and this must go on to that extent, that suburban building will be checked, the population will be concentrated within the interior, or, by means of the suburban railways, enabled to choose their sleeping places and family establishments wholly in the country, instead of the mongrel villas and cottages of the suburbs, having all the inconvenience of a town residence, with the remoteness of a country site, and without either garden ground for the children or green fields. As the *Times* has well pointed out, a large space in the inner ring, as it were, of the metropolis, otherwise valuable for building ground, is covered with miserable courts and alleys, which can be obtained at a moderate price; and, in the end, these will be exterminated, and space will be given for large dwellings and for public establishments.

There is no occasion to remove either the learned societies, or the National Gallery from the neighbourhoods they now occupy, as a class of improvements similar to those in Paris, nay, similar to Victoria-street and Cannon-street, will give sites as cheap as Kensington, if not cheaper, and much more accessible. Any appropriation of Kensington must be with due attention to the course of events; and this is a most unpropitious period for the establishment there of any institution which is to be readily accessible; for, independently of what has been already stated, the admission of railways to the heart of the metropolis, and more particularly the recognition of suburban, have given greater advantages for the concentration of the population of the vast area within the old seat of business. It may, too, with truth be said, since the establishment of the railway system, that all England is a suburb of the metropolis, so far as the public collections are concerned, or any great celebration. The convenience of these visitants must, therefore, be consulted, by avoiding any out-of-the-way place for a public establishment, unless of an exceptional character.

The state of affairs as to the Kensington site is, that the site has been obtained, and there are no funds to do anything with it, nor, as we have said, any sufficient scheme for the appropriation of funds. Mr. Cole (Felix Summerley, C.B.), who was one of the persons connected with the Great Exhibition of 1851, as he still is with those who may be called its executors and legatees, has published a pamphlet, which he represents as being under the auspices of Prince Albert. The purport of this pamphlet is to recommend that the site shall be turned over to a joint-stock company, the operations of which Mr. Cole does not specify, though he states, in a dedication to Prince Albert, that he is prepared to do so whenever it may be considered necessary. Mr. Cole is the best judge of the propriety of this reserve and demand of confidence, which appears too close a copy of Sir Robert Peel in a memorable period of political emergency.

It is rather a strange testimony to Mr. Cole's impartiality as a witness, that he propounds strong statements against the efficiency of government management, though he has been long a government employee, having first held a clerkship in some office, and latterly, on the strength of his Felix Summerley productions, having the good luck to be put at the head of the department of practical art, with a very liberal salary. We have expressed very strong opinions as to the efficiency of government management and officials, but we are outdone by Mr. Cole, and we think he has drawn his case so strongly that we are not able to endorse all his statements.

Mr. Cole seems to think that a very large sum of money will be required, and that it will be advisable that the management, to insure responsibility and unity of action, should consist only of one person, or, at most, three persons. Mr. Cole seems to think the legislature or the government will never grant such powers, or repose such trust. Here we differ from him, for we think they will. With regard to one point he mentions, an Historical Gallery of Painting and Sculpture, we fully expect that the funds will be provided, and that a competent director will be entrusted with their disposal. If, however, Mr. Cole means that he, or some other of the Great Exhibition officials, is to be entrusted with an unlimited control over the very large expenditure of public funds for some undefined object, we think he is quite right in assuming that the Legislature or Executive will never countenance anything of the kind. It is, however, a misrepresentation that the Legislature will not liberally provide for our acknowledged institutions or grant extensive powers. The British Museum surely has no reason to complain of want of confidence. The Department of Education, although new, has already been largely endowed, and is allowed to dispose of its funds without parliamentary interference in details. The National Gallery and Schools of Design year by year receive further endowments. Kew Gardens, under Sir William Hooker, has become an establishment of which the nation may be proud; nor are we aware that Greenwich Observatory has any ground of complaint. Where there is a ground of complaint, it is not, as Mr. Cole alleges; for the legislature do liberally endow, and grant full confidence; but it is, that there being no proper minister of education or of the fine arts, there is too much power in individual departments, too little control over them; and the want of a systematic organisation, whereby neglected objects might be provided for, and the fullest results obtained from existing institutions. The expenditure of the government is lavish, and if Mr. Cole and his patrons can really make out a case for a useful institution, they will have no ground to complain of the measure of support.

A very strange position taken by Mr. Cole is that government bodies are much less prudent, and much less bold in the

* "Observations on the Expediency of Carrying out the Proposals of the Commissioners for the Exhibition of 1851, for the Promotion of Institutions of Science and Art at Kensington, rather by the Public themselves than by Government." (Submitted, by permission, to H.R.H. Prince Albert, President of the Royal Commission.) By Henry Cole, C.B. London: Chapman and Hall. 1853.

application and expenditure of money, because the money is the property of the public generally, and each individual at all interested considers he has a right to give his opinion on the mode in which they ought to be employed. This he does not consider to be the case with the directors of a public company. Our readers, who are more conversant with these matters, will differ in opinion with Mr. Felix Summerley. The British Museum and National Gallery managers have certainly not troubled themselves about individual suggestions or public criticism; and joint-stock companies, as railway directors well enough know, are particularly open to the interference of their shareholders. Had the writer instituted a comparison between individual management and that of boards, government or joint-stock, he would have been able to speak of the superior energy of one as compared with the other, but his preference for a joint-stock company is not supported by the arguments he adduces.

Another strange plea of Mr. Summerley is, that the administration of the government boards is constantly undergoing inquiry, and he enumerates several boards. This he adduces as a proof of the suspicion under which they lay. He quite forgets that railways, banks, assurance companies, and other joint-stock institutions, have been quite as often the subjects of inquiry and legislation; and if he had a Great Exhibition Company, or a Great Exhibition Commission, it would be just as liable to inquiry on public grounds by the legislature. He has also a notion that directors are more liable to penalties for malversation than government officials, but he does not refer to any evidence or experience of his own on the subject, and the state of the law gives no countenance for any such doctrine.

Other circumstances on which Mr. Cole relies are, that in the middle ages the churches were not built by the government but by the people, and that of late, canals, railways, &c. are the results of individual enterprise. This has nothing to do with museums and galleries of art, which are not remunerative undertakings, nor have any religious or superstitious recommendations. Of course Mr. Cole brings in that successive governments declined to undertake a national exhibition of industry, and, as he says, would probably do so again, and that at no time did the government give much countenance or help to the Exhibition. The Exhibition of 1851 was an exhibition of charlatanism and puerility, with the smallest amount of practical results and with a large amount of scandalous jobbery for the glorification of a contemptible clique. The manufacturers of this country have no particular reason to be satisfied with a performance in which they were treated with neglect and foreigners favoured; and the government had so much trouble and so little satisfaction with the exhibition and its concoctors, that they will not very readily subject themselves to a repetition of it.

Mr. Cole makes a comparison between private institutions for promoting science and art and those of the government, and says that the latter always suffer by it, instancing the Tower menagerie and the Zoological Gardens, and forgetting Kew and the Royal Botanic Gardens, Regent's-park. He therefore advocates "self-supporting" institutions, forgetting that for educational purposes we want not "self-supporting" but free institutions to put us on a level with our French rivals and American brethren. In confirmation of his dictum he says it is characteristic of the people of this country, that they do not value so much anything obtained gratuitously as that which they pay for, which is directly in the teeth of evidence; and we need go no further than the British Museum for that. He further says that there is an increasing dislike of the large provincial towns to the monopoly in London of great institutions to be paid for from the general taxation. This is a misrepresentation. The provincial populations do not complain of the British Museum, the National Gallery, or national institutions, which are used as much by them as by the Londoners: but they do complain, and justly, that they have not local museums, galleries, and libraries, which a better organisation gives to continental towns.

On these various assertions Mr. Cole contends that the plans for Kensington ought to be realised with the same success as the Great Exhibition, and the Crystal Palace at Sydenham, and that a joint-stock company should be formed for such purpose, to whom the area should be assigned, the government having a right of buying the whole or a part of the buildings, and of buying free admission for the public. Mr. Cole's joint-stock company is to erect spacious and attractive buildings for exhibiting collections, illustrative of the progress of science and art; the formation of the collections and "the execution of various extensive works conducive to popular improvement and recreation,"—in fact, so far as we can understand, to be an opposition Crystal Palace Company. Besides giving the area, the government are to be invited to lend or present to the company the National, Vernon, and other public galleries and collections, and to "agree to pay a fair rental for the space occupied by them."

We cannot say that Mr. Cole has made out any case for the support of the legislature or executive government, by grants or enactments in favour of his scheme, for we do not think they should be engaged in a kind of Crystal Palace, Vauxhall, or Hippodrome, which should properly be left to other speculators. If Mr. Cole, the Crystal Palace directors, Mr. Batty, or Mr. Charles Kean, while catering for the public amusement, choose to promote the cause of education by classical or artistic illustrations, we are thankful to them; but we see no reason to subsidise Mr. Cole or his company to enter into rivalry with the proprietors of theatres and exhibitions.

If it be true that the Kensington scheme has failed, it might be advantageous to sell the land to Mr. Cole and his joint-stock company to erect glyptothecas, colosseums, Mount Etnas, panopticons, glaciariums, pantheons, and hippodromes, as they may think most profitable. The funds from the sale of the area may be applied to the extension of the National Gallery, the building of a new one, or the formation of an industrial museum.

## PROPELLERS.

James Spotswood Wilson, *Patentee*, Nov. 8, 1853.

The inventor states, that the proper place for the application of the propelling force, to promote horizontal motion, is at the centre of gravity, and this, in other cases, is generally found true in practice—as, for instance, in the paddle-wheel of the steamship, and the driving-wheel of the locomotive steam-engine—and the proper position in which to apply the force in order to produce the largest amount of horizontal motion in proportion to the power employed. He learns from many examples, both in nature and art, that such position is at an angle of inclination 45° from the horizon. But his principal reasons for adopting that angle with regard to marine propellers is in consideration of the fact, that water increases in force in an equal ratio with the depth, from which arises its mean resistance at that inclination, and that the mean velocity of a falling body is obtained in that inclination also. By causing the power to act in the line of the former at that angle, upward gravity will be brought into action at a corresponding angle downward, but at right angles to the former, the resultant of which will be horizontal motion. The outer end of the propeller-blade, from its greater rapidity of motion, passes through a greater space than the portions nearest to the axle, and therefore does not require so much breadth of blade. In natural examples, we find that the fastest swimmers among fishes have their tails divided into long tapering lobes, instead of one broad sheet, and the swiftest among birds have long tapering wings. In imitation of these models afforded by nature the patentee forms his propeller, and therefore terms it the "Wing Propeller," not only on account of its situation and form, but likewise to distinguish it from the screw-propeller, as it does not retain any portion of the spiral character.

The vibration experienced in screw-propelled ships arises from the unequal density of the water in which the propeller acts; the force opposed increases in proportion to the depth, and the violence of the vibration is in proportion to the velocity. By the application of the wing propeller in the angular position (as represented in the engraving, fig. 1), the vibration would be completely removed—in consequence, first, of their acting in the line of mean resistance, by which means the difference arising from density would be one-half equalised; and secondly, their blades being made tapering toward their outward extremities, the forces and velocities would be more equally proportioned to the different sections of the diameter. It will be seen by the engraving that the propeller represents a pair of revolving wings. At figs. 3 and 4 it will be seen that the descending wings D, D, act like those of a bird, nearly horizontal, but descending in the line of mean resistance; while the ascending blades E, E, rise in a nearly vertical position, and press backward at the same time in a manner similar to the action of an oar in rowing.

The manner in which the patentee proposes to make the wing-propeller suitable as an auxiliary power is according to the following description. The propeller-shaft is traversed spirally by a broad screw-thread, on which the propeller (fig. 2) fits; while at work the action will keep it firmly down to the collar D;

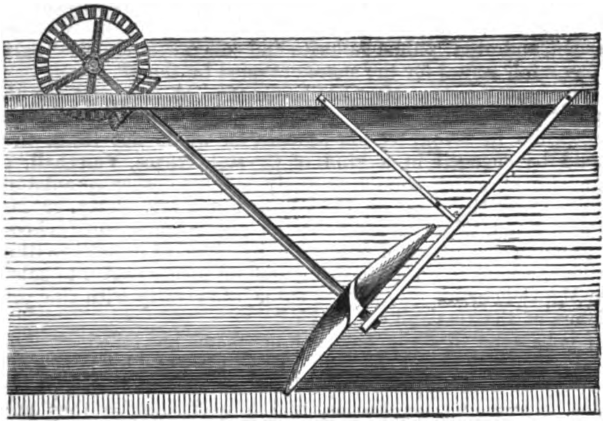


FIG. 1.

but when the engine is stopped and the ship continues in motion, the resistance of the water will cause the propeller to turn on the shaft, and in so doing it will travel up the screw, so that all that is necessary to be done in order to draw the propeller out of the water is to stop the engine or reverse the motion.

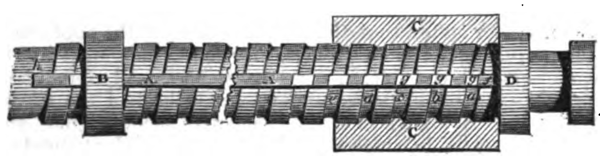


FIG. 2.

In ocean steamers the necessity for being able to back water is not great, and is likely to occur only when coming into or leaving port. The patentee would therefore prefer to avoid providing for that evolution rather than to encumber his apparatus with a complicated mechanical arrangement. Yet, that his auxiliary shaft and propeller may be as perfect as possible, he contrives to key the propeller to its place in so simple a manner that it may be secured or liberated in a moment. To effect this, he proposes making the screw-thread on the shaft considerably broader than the spaces *a, b, c, d, e*, between its spiral revolutions; then, by having a key-way running the full length of the screw on the shaft, and sunk about half-an-inch deeper than the spiral thread, and a corresponding way inside the propeller; also, the lower end of the key A, A, should be formed so as to make good the deficiency of the screw-thread when the propeller is at liberty to ascend, but having space *f*, at its lower end to allow of its being driven down so as to permit the portions of thread to pass across

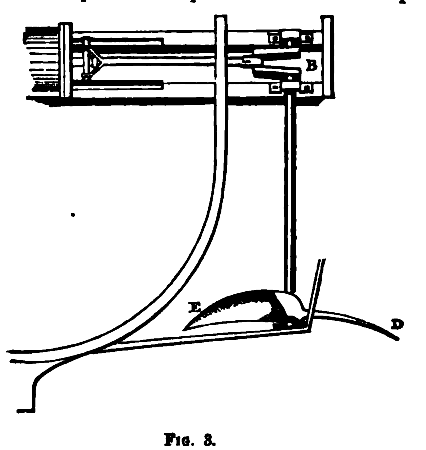



FIG. 3.

the spaces *a, b, c, d, e*, as shown at *g, g*, by which means the propeller would be prevented from turning on the shaft. The upper end of the key should be furnished with a nut B, fitted in such a manner, that when being run on it, it would drive the key A, A, down, and on being drawn off it would draw the key with it into the space *h*, and liberate the propeller. In applying the power, the patentee proposes using only one steam-engine for one pair of propellers by placing the cylinder thereof horizontally across the ship, level with and in a line with the centres of the two cranks B, B, figs. 3 and 4, and furnishing it with one piston and two piston-rods, or rather one piston-rod passing through the piston and out of each end of the cylinder, so as to act like a double engine by having each end connected with a crank-rod. Figs. 3 and 4 represent the mode of application, by comparing which with the modes in use may be observed the amount of machinery that would be dispensed with, and the smallness of the space that need be occupied by the engine. To increase the velocity of the ship under this arrangement, the propeller wings should be lengthened, the stroke of the engine

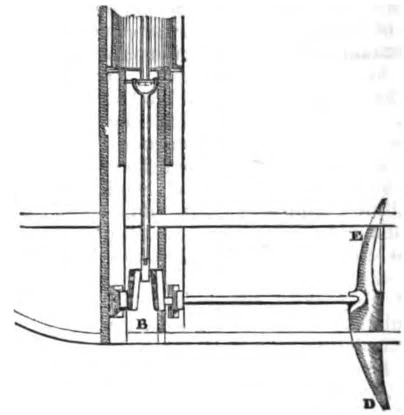



FIG. 4.

shortened, and the diameter of the cylinder increased to compensate for loss of leverage in the cranks. But as regards engines such as are constructed in the paddle-wheel steam-ships, they may be applied by using bevil gear to connect the propeller and engine shafts, and to multiply the velocity to the required amount.

*Claims.*—1. The peculiar form of the propeller-blades hereinbefore described and illustrated; 2. The exclusive right of fixing a shaft or rod on the sides of a ship or other marine vessel in an angular position, as hereinbefore described; 3. The connecting of these shafts or rods by cranks to the pistons of a steam-engine, the cylinders of which engine shall be laid horizontally athwart the ship, and have a piston-rod working through each end; 4. The mode of lifting the propeller by means of a spiral thread or screw encircling the shaft, as described.

## ESCAPE WATER-VALVE FOR MARINE STEAM-ENGINES.

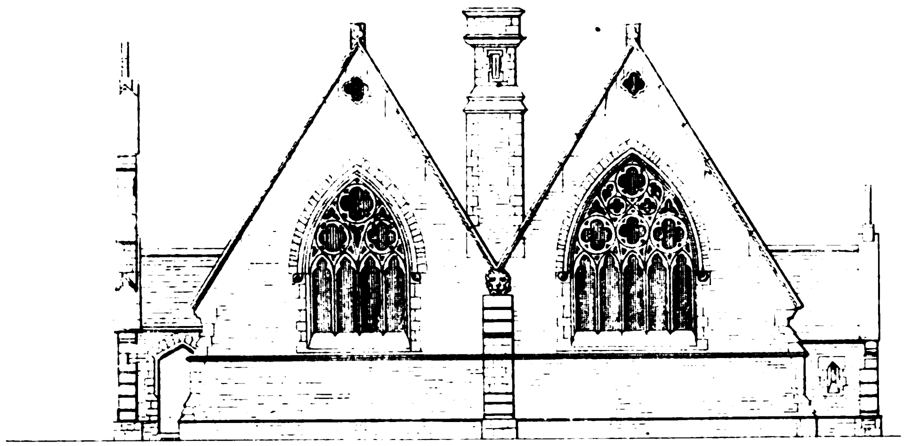
By ROBERT WADDELL, of Liverpool.

[*Paper read at the Institution of Mechanical Engineers.*]

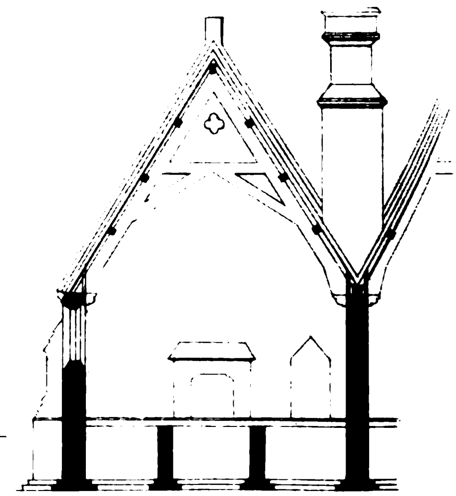
THE horizontal engine has of late years become a favourite engine in the British navy, for the screw steam ships have the advantage of being better protected from shot than the vertical engine, as the horizontal engine can be placed in the ship entirely under the water line; the boilers are also kept as much under the water line as possible, for the same purpose. All boilers are liable to prime, but when they are confined in the height of steam room, they are more apt to do so, as in this case, and carry a considerable portion of water from the boilers into the cylinders along with the steam. Water in the cylinders has, no doubt, been the cause of more accidents to engines than anything else; and many cases occur of the bottoms of cylinders being forced out, pistons broken, piston-rods bent, and side-levers broken—all from the effects of water in the cylinder. This can easily be accounted for, from the great power the one engine has over the other when water accumulates in the cylinder; the two engines being connected together in right angles, if a few inches of water has got into one cylinder, which will prevent the piston from getting to the end of its stroke, the opposite engine will be near half-stroke, at which point it gives out the greatest power, as the piston and crank are travelling near the same velocity, while the piston of the first engine, from the position of the crank, is nearly at a stand; then the power of the second engine, exerted to compress

# HASLINGDEN SCHOOLS.

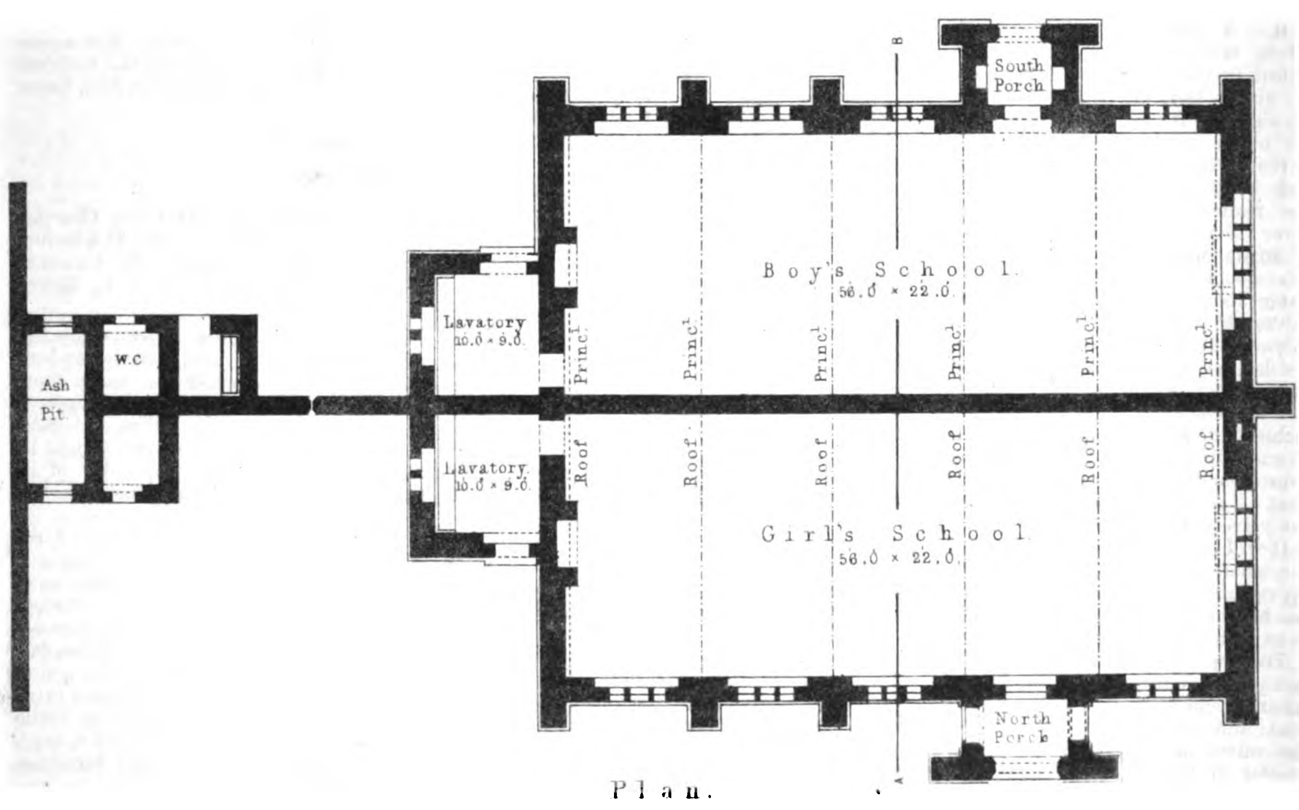
Thos Holmes, Archt



West Elevation.



Half Section on the line A.B of Plan.




Plan.

J R Jobbins

the water, will be in proportion to the difference of velocity of the two pistons, plus the momentum of the engine. The fly-wheel of the land-engine acts on it in the same way when the engine is turning its centre.

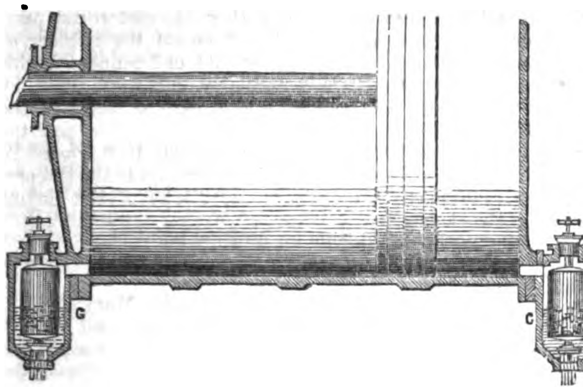


Fig. 1.

Escape water valves have been applied on cylinders to take off the water, to prevent accidents taking place from the accumulation of water in them, but with little success. The fault of the ordinary escape water-valve is its being loaded like a safety-valve, so that no water can leave the cylinder till the piston forces it out, and then the strain is very severe, from the small area that the water has to pass through, which causes the damage to the engine.

The object of the improved escape-valve, described in the present paper, is to draw the water off the cylinder throughout the stroke, and not allow it to accumulate, as with the ordinary escape-valves, till the piston strikes the water. The construction of the valve is shown in the accompanying engravings. Fig. 1 is a horizontal cylinder, with an escape water-valve attached to each end, to the flange G, shown separately in fig. 2. B, is a small cylinder attached at G; F, is a float inside the cylinder, a spindle passes through the float, and is attached to it. A, and C, are two conical valves nearly in equilibrium, attached to the spindle with nuts at top and bottom of the cylinder; the top valve A, is made like a piston on the under side, so that when it leaves its seat it will prevent a great rush of steam from passing. It is also made slightly larger than the lower valve C, so that the pressure of steam will assist in raising the valves, and a small accumulation of water about the float will open the valves; that is, suppose the float, valves, and spindle weigh 50 lb. for the largest size of engine, and the pressure of steam in the boilers not to exceed 15 lb. per square inch, and the top valve to be 3 inches more area than the bottom; then there will be three times 15 = 45 lb. excess of pressure on the upper valve, being within a few pounds of raising the valves, without any water about the float. The float should be made with sufficient buoyancy to raise the valves when there is no pressure of steam to assist.

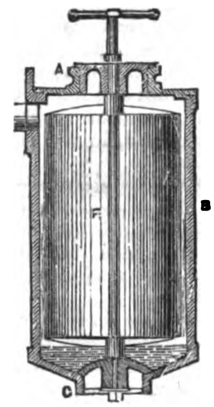


Fig. 2.

It will be seen from the construction that when water enters the small cylinder from the steam-cylinder, the float is buoyed up, opening the valves and allowing the water to escape through the bottom of the small cylinder. There is a hole in the spindle to carry off any water that might collect in the float.

The top valve is made larger than the bottom one to answer two purposes, namely, for the pressure of the steam to assist in raising them when a small quantity of water comes about the float; and, secondly, when a vacuum is formed in the cylinder the valves are kept shut by the atmospheric pressure being greater on the top valve than the bottom one; this will be the case if a great quantity of water enters the steam cylinder, the valves will then be kept open running it off, until the exhaust takes place.

The drawings show an escape-valve suited to a 400-horse power engine, with 93-inch steam cylinder; the escape-valves will then be about 6 inches diameter, and the float about 13 inches; this will give the float sufficient buoyancy to rise and open the valves before it is entirely covered with water, besides the assistance of the differential steam pressure on the valves.

## HASLINGDEN PARISH CHURCH SCHOOLS, LANCASHIRE.

(*With an Engraving, Plate* II.)

These schools are near the parish church, and have a most commanding prospect, looking over hill and dale, and bordering on an extensive churchyard, by which it is bounded on three sides. The style of building is of the early Decorated period. The plan consists of two schools, one for boys, the other for girls, each 56 feet long by 22 feet broad, with lavatories and conveniences attached. A spacious playground at the back of each is now in course of formation. There are north and south porches, the latter forming a lofty bell turret, as seen on the engraving. The walling of the schools is composed of thin flag pierrepoints, varying from 3 to 4 inches deep, of a rich, warm brown colour, with dressings of a light-coloured freestone. The walling is pitch-faced, the dressings tooled.

The western windows are large, deeply and richly foliated, and the chimneys, instead of being, as is often the case in buildings of this kind, an eyesore, are a set-off and finish to the different facades. The interior of the schools are open to the slating, with bold chamfered and dressed principals, and the heated air is removable by the aid of triangular-hinged and ornamented ventilators, worked by cord and pulleys on the school walls. The whole of the woodwork is stained and varnished. The doorways have large flowing and ornamental wrought-iron hinges and stancheons, with escutcheon locks, and handles of the same style. The chimney pieces are in keeping with the school, being exceedingly quaint in their design. It is intended to throw down a portion of the present wall of the churchyard and erect a low deeply-coped one, with buttresses every 12 or 14 feet apart, filled in between with a neat, plain railing of an ecclesiastical pattern, and which will add greatly to the beauty of the whole.

The approach to the schools is intended by an arched portal from the west leading to each porch.

The cost of the entire works will be about 1350*l.* The architect is Mr. Thomas Holmes, of Bury, Lancashire; the builders are natives of Haslingden. The parish church itself, which forms a back ground, is to be rebuilt.

## REVIEWS.

*Illustrations of the Spires and Towers of the Mediæval Churches of England, preceded by some Observations on the Architecture of the Middle Ages, and its Spire Growth.* By Charles Wickes, Architect. In Two Volumes. Vol. I., *Spires.* London: Weale. 1853-4.

The current topics of the day are, to a great degree, echoed in its general literature. And this is but natural, considering how intimately they are related. Questions which demand a more than ordinary range of thought, or that occupy a large share of public attention, can best be discussed in the arena of letters, and it is no bad criterion of the importance of a theme to find its salient points vigorously contested, or of the difficulty of its solution by the number and array of names enlisted in the investigation.

Undoubtedly, one of the most remarkable features of the present day (in the world of art at least), and a fruitful source of agitation, is the active sympathy which has been excited in all that pertains to the productions of mediæval times. Curious books and manuscripts have been hunted out—old relics stored—quaint carvings furbished up—the gorgeous pile and desolate ruin alike explored, in due devotion to that mysterious genius which presided over the craftsmen of the age, and stamped originality, beauty, and variety on their handiwork. Modern artificers are their humble imitators, and, creeping before they venture to walk, will furnish us with churches, houses, and furniture, "done after approved Gothic forms."

Whether all this be, as some will have it, a mere mania, shortly to disappear like other whims, or destined to survive, remains to be seen; but where the advocates of a movement claim for it the sanction of common-sense, adaptability, and experience, backed, moreover, by practical evidence (and one fact is worth a host of theories), their arguments are worthy of every consideration. Personal research is in all cases to be preferred; but failing this, the patient labours of others. In both these respects, the study of our ancient architecture is greatly facilitated: our railroads wing us through the length and breadth of the land, and our mine of information is continually receiving valuable accessions from the press.

Among the most notable of those which have lately seen the light is the one now before us, by Mr. C. Wickes, architect, of Leicester, who has produced a large and beautiful work on the 'Spires and Towers of the Mediæval Churches of England.' This book has been long in preparation; indeed, the author states in his preface that it "was commenced by him *imberbis adhuc.*" It is gratifying, on referring to the prospectus, to find that the promises therein made have been rigidly observed; that the lithographs are equal in fidelity and artistic effect to anything of the kind hitherto produced, and that the style of finish throughout is in excellent taste. The scale of the delineations is ample, showing the character of even the smaller parts with commendable accuracy. It is just the kind of work likely to be serviceable;—to the professional man in bringing before him some of the choicest realisations of his art, which he is thus enabled to analyse and compare; and to the community at large in propitiating them in favour of what is often rendered a needlessly dry and insipid study.

The letterpress is devoted chiefly to the history and progress of mediæval architecture, and the modifications it assumed in its various stages are cursorily defined. This part of the work is evidently prepared more for the benefit of the uninitiated than the experienced reader; but, inasmuch as it is not devoid of technical expressions, and is totally unaccompanied by diagrams (that invaluable assistance), it might have been rendered more generally useful. Then again, when the author, having traced the distinctive features in the different styles,—in the nomenclature of which, by-the-bye, we see he follows Rickman,—sums up the beauties of all in so eulogistic a manner, one might almost be disposed to infer, that, to use an Irishism, each is the most perfect of all the rest. Thus, after remarking on the *Early English*, and quoting Mr. E. A. Freeman's opinion, that its detail "possesses the most exquisite loveliness of any style of architecture whatever," he adds, "In conclusion, we would again draw attention to the peculiar interest that attaches to this style, and the claims that it has on our national regard." In dilating on the succeeding style (*Decorated*), he pictures a fabric in all its glories, and pronounces on it that "Art has exhausted her powers," &c. Of *Perpendicular*, "We would remark on its wonderful adaptability to all the requirements of church architecture, and its consequent claims to be recognised in this the 19th century as our national style."—(What will some of our ecclesiologists say to this?)

Doubtless Mr. Wickes is able to reconcile these opinions, and would have explained himself more fully, but for the fear of adding too much to an already bulky volume, and thereby rendered it inconvenient for reference, besides increasing the cost of its production. Nor is this latter consideration a minor one; it is notorious that architectural works (exclusively such) are seldom remunerative, and for this reason, that while the outlay necessarily incurred is often large, if they are of any pretensions, the proportion of readers of that class of book is but comparatively small. Hence we cannot be surprised if an author, only on the score of policy, endeavour to make his book attractive beyond its more immediate sphere; and hence the desultory and superficial tone it is apt to assume. But when, as in the present instance, a comprehensive subject is taken in hand, it ought to be fully, fairly, and systematically met. And, notwithstanding the high commendation to which the work is entitled, there are several points to which, in our critical capacity, we are compelled to take exception.

It appears to us an error of judgment that, in the letterpress, the illustrations, which are the main features of the book, are but here and there alluded to, and that incidentally. The author acknowledges this, but promises in another volume a detailed and critical examination of each. But, besides the implied presumption that every possessor of this volume will have the other also, this second is to consist solely of *Towers*, so that the separation is both inconvenient and unnatural. We could better have spared the Historical Essay than these explanatory notes.

Nor, turning to the plates, do we see any reason for their irregular order, although we have read the author's paragraph subjoined to the index. This would be scarcely worth notice, but that by the present arrangement they are deprived of all chronological interest. Ranged according to their approximate dates in the second index, they would have been far more consistent and useful than studied variety. It may be preferable, however, to reserve our remarks on this head till we have made our readers more familiar with the work by a sort of running comment on its contents.

First, then, we are presented with a glorious view of the triple-spired cathedral of Lichfield, lithographed to perfection, and forming an appropriate frontispiece. Two other cathedrals are included in the series, viz.: Salisbury, a worthy companion to the former, and Peterborough, from an unusual point of view, showing the fanciful design of the south-west tower and portions adjoining.

From Stamford two specimens are selected, St. Mary's and All Saints. The first is a well-known example, compound in style, yet harmonious in outline and detail. All Saints has some good points, but scarcely sufficiently important for special illustration. Of the north entrance, which is curious, but a glimpse is caught. Belfry windows of this type (double under a comprising arch) show a better example in Grantham (Pl. 5); and of the turretted parapet (a not very common design), Kettering, Exton, and Oundle, are given in other plates.

Kettering (Pl. 13), is one of the best Perpendicular steeples, and derives additional advantage from its favourable site.

Exton is also a successful design. The tower parapet, as we have just stated, has turrets at the angles, and from within springs an octagonal lantern crowned with a spire.

Plate 3 exhibits a careful drawing of Raunds tower and spire, one of the purest and loftiest in Northamptonshire, and early in date.

The next illustration is Keystone, Huntingdonshire, which has never, to our knowledge, been published before. It is a charmingly simple and good design. The panelling above the belfry story is unusual, but in keeping with the style, and so is the beautiful little square window set angularly in the first stage of the tower. The doorway below is exceedingly rich and effective. Though the double archway here introduced is not uncommon, the gabled and pinnacled exterior is a localism of which the same idea is traceable in Rushden (Pl. 25,) as also in Oundle (Pl. 15). Swineshead, in the same county is, if we recollect, another instance.

The magnificent steeple of Grantham next comes before us. The direct west view of this church is surpassingly grand. From that point it is not seen that the upper part of the aisle walls is a useless mask, and undoubtedly a great blemish in the design; as is also a similar instance, in the west front of Salisbury Cathedral.

Next we have views of Newark, and St. Mary's Redcliffe, Bristol—both well known.

Not so is Bloxham, a particularly interesting specimen, unique in design, whose beauties are at first scarcely appreciable in the outline plate. The diagonal buttresses to tower, and their mode of transition into other forms, are deserving of study, as are also the west doorway and the details generally, which are of unusual character.

Patrington is a curious design, also unique; this view includes the whole of the west end of the church, a valuable example. Oundle (Pl. 15) has all the characteristics of the Perpendicular style most severely carried out. We have before referred to its turrets. In striking contrast with this we have in the next plate a view of Louth steeple, an earlier offspring of the same style, and perhaps its most symmetrical specimen.

Next leaf but one we find its rival, St. Michael's, Coventry, a still more elaborate composition. This spire is loftier than that of any other parish church in England, being about 300 feet high; that of Louth is a trifle less. The beauty of the lantern between tower and spire, and the light double-flying buttresses have often been noted. The construction has been also evidently planned with mathematical study.

St. Nicholas, Newcastle-on-Tyne, is another triumph in construction, and well known.

Ketton is a beautiful example, and so is Market Harborough, but the latter is not here shown to advantage. The spire, too, is not quite perspectively correct at the eaves, which gives it a heavy appearance, inconsistent with the original.

Walcot, in the same plate, we suppose is to be accepted as a specimen of that class of steeple of which Ewerby stands the pre-eminent type. The author, alluding to the latter steeple and others, states that they would have found a place in his list had they not been so well illustrated in former publications; but the same might be said of others which he has admitted; yet the omission of Ewerby we think a great mistake, as, though it is simplicity itself as regards its parts, the exquisite proportions constitute it, probably, the most perfect steeple in existence.

Desborough is plain and good. (Where is its soaring neighbour, Stanion?)

Bythorne is a very poor affair, and yet within a stone's throw of Keystone. (See Pl. 4). It is the most indifferent in this collection.

The examples to which we have now arrived are drawn to a smaller scale than those in the earlier part of the volume—(it may be through press of matter)—but, generally speaking, they are clearly interpreted. We should have liked to have seen Rushden on a separate plate; it is a most superb design and cannot be too well studied.

Thaxted is another favourite. Steeples are rare in Essex, and we are glad to see this has not been overlooked. Lostwithiel is a curious little tower and spire. The sloping back from square to octagon is quite a Cornish peculiarity. There are several other specimens in this work, partaking very much of characteristics already enumerated. Indeed, this appears a fault in the series, that variety as to style and type has not been sufficiently exhibited. There is a progressive history which may be traced in the subject, and which the scope of this work might have instructively realised. Early examples, showing the successive transitions, might have been more freely introduced without diminishing the general interest.

Sutton St. Mary's is the only example given of a certain class (as Bibury and Almondbury); while the earlier shingle spires, such as abound in the once woody parts of England, are totally unrepresented. Horsham, or Lindfield (Sussex), would have been good instances.

Then we miss altogether a class of spires, of which Warmington, Hallaton, and Sleaford are such marked specimens. And again, St. Peter's, Aldwinkle, later in style. That of Warmington is one of the earliest stone spires known, and one of the most enriched. Perhaps it may be said, that it is already familiar; but still it deserves a place in illustrations of "spire growth." We have a right to expect at least one example of every development of a principle. Enrichment is not indispensable; some of the most valuable are indebted to their outline only.

The author appears to have confined himself too exclusively to the acceptedly beautiful proportion of nearly equal tower and spire, and other characteristics of those glorious groups which are to be met with in Lincolnshire and Northamptonshire. But there is a vast diversity in feeling created between the proportions of the needle-like Glinton and its diminutive neighbour Helpstone, without holding up to admiration either extreme.

There is effect also in materials as well as form, as the parti-banded masonry of Irchester will show, which we should like to have seen illustrated among the rest, as also a few diagonally buttressed towers, such as at St. Sepulchre's, Northampton.

In default of more palpable delineation, we shall look for a due recognition of all these features in the forthcoming history, as far as *description* will serve; but we strongly recommend a few marginal diagrams, if only in outline. The idea, which is but imperfectly conveyed by a multitude of words, may be often correctly expressed by this means in a tithe of the space. And we would moreover suggest,—and the thought may have possibly occurred to the author,—that from the mass of information which he must have accumulated, but which it will be impossible otherwise to make use of, an interesting and invaluable tabular list might be compiled and appended to his descriptions, indicating the several features of towers and spires (arranged chronologically, as far as possible), the leading features of their design, and other items, which would make the information on the subject generally as complete and useful as possible.

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*The First Principles of Perspective Explained Theoretically and Practically, in a Course of Easy Studies.* By Felix Duffin. London: Spon, Bucklersbury. 1853.

In his introduction Mr. Duffin very justly observes:—

"To many, at first sight, the study of perspective has appeared so much enveloped in mystery that the idea of progress therein in the only manner likely to afford a feeling of satisfaction has been abandoned at the outset, owing to the dread of difficulty, while, in point of fact, the principles of the science are theoretically simple, their application practically, of great utility in the ordinary intercourse of life, and certainly most elegant adaptations of mathematical science."

This "mystery" that Mr. Duffin alludes to arises from the complex system (to most) in which writers on perspective seem to delight in shrouding themselves, as if for the express purpose of preventing ordinary students (who generally have not time to throw away in unnecessarily lengthened explanations) from grappling with the subject.

Another thing which occurs in this pamphlet, as in most others, is a number of unnecessary geometrical problems, of little use except to make the book look thicker, for we really cannot believe that it is required to show to the generality of students in perspective, how to draw two parallel lines, and some other of the propositions found in the first book of Euclid, as, for instance, "To let fall a perpendicular from a given point on a line," "To form an equilateral triangle upon a given line," &c. But should it be really necessary in teaching perspective to the young idea, we are only very sorry for it, and regret that geometry is so little understood as to require the insertion of such in works on perspective. However, we recommend the perusal of Mr. Duffin's very cheap and useful little book to those who may require information on the subject; and the different objects in the plates, the plane of picture, plans of subjects to be represented, &c., having a slight tint of colour on them makes them more easily understood.

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*Practical Remarks on Railways and Permanent Way, as adapted to the various Requirements of Transit.* By William Bridges Adams, Engineer. London: Effingham Wilson. 1853.

Mr. Adams has been long known to the railway public for his practical economics in the mechanical operations of railways, adjusting means to ends with a view to the combined profit of the shareholders and the accommodation of the public, demonstrating in his former work on 'Road Progress,' and elsewhere, that for passenger-traffic light and frequent trains would best subserve the public wants, and at the same time diminish the wear of the moving and fixed plant, and which improvements were noticed some years back in this periodical. Mr. Adams is also known to the building world as the inventor of improvements in street paving and drainage, with the object of getting rid of dust, mud, and water, and avoiding annoyance to passengers and shopkeepers; and also for a mode of constructing flat floors or roofs of great span and duplicated strength without intermediate supports below. Apart from his improvements in locomotive engines and carriage machinery in all its branches—which may be found partially described in the 'Railway Machinery' of Mr. D. K. Clark,—Mr. Adams has been a large contributor to the press on mechanical as well as intellectual and moral subjects, and more especially as connected with general progress and the improvement of the working classes. Many of his contributions have been anonymous in the *Westminster Review* and other publications, and to some he has appended his name. His work on 'English Pleasure Carriages' is well known, as also 'Road Progress,' and other similar subjects; but many of his anonymous contributions are not generally known as from him. In the *Mechanics' Magazine* of 1831, there is to be found a paper of his, entitled 'Better Housing the Working Classes,' the original proposition for the model lodging-houses of the present day; and in another paper, in 1848, the same plans are advocated at greater length; but the buildings on Mr. Adams's system have yet to be produced. In a paper in the *Monthly Repository* on 'Housebuilding and Housekeeping,' the same plans are advocated for the middle classes. About the period of the first paper we find, amongst other minor things, a proposition of his for the identical steel-ribbed umbrellas of the present day. In the proceedings of the Institution of Civil Engineers it stands on record that Mr. Adams was the first originator, in the pages of the *Westminster Review*, of the glass and iron structure in Hyde-park, known as the Crystal Palace. We may add that in the pages of the *Journal of the Society of Arts* he has been a strenuous defender of the claims of originators under the protection of Patent Law, and in the columns of the *Spectator* are to be found many contributions of his on mechanical and other subjects, more especially on the important question of the "storage of grain," so as to produce "equalisation of price." The gold question has also been treated by him, showing the probability of the abundance of gold previous to the Californian discoveries.

Mr. Adams has been for a long period a worker for the public, and we have given this brief sketch of his labours because his writings have never been collected together, and few know where to refer to them.

The present publication deals, in the first place, with the economical question of railways, as to their uses to the public and the various classes of railways that are required; for it is a great mistake to suppose that all railways, whether trunk or main, or minor branches, should all be made on the same system, and this mistake has been the source of much mischief to the great lines.

In the opinion of Mr. Adams it is impracticable to run fast express trains on the same lines as heavy and frequent goods trains, with any safety to the public; and he thinks that there is wealth enough in many of our cities to pay for the construction and working of especial passenger lines at forty to fifty miles per hour, at a moderate rate of mileage. After demonstrating the principles that should govern the construction of permanent way, and of the engines to run on it, he thus proceeds:—

"Assuming the foregoing to be the principles that should govern the structure of rails and locomotives, the next consideration is, the social and commercial requirements. Let us first consider the question of

*High Speed Lines.*—Passenger trains actually travel at speeds of from 50 to 60 miles per hour on rails in inferior condition. This rate of speed involves considerable risk from bad joints, and from collisions with other trains travelling at various rates of speed. If light engines and light trains were used with corresponding rails in thorough order, and with no impeding traffic, these rates of speed might be maintained without any risk, and without any immoderate cost. But it would not do to permit any heavy destructive goods' traffic on such lines. If goods were permitted the engines and wagons should be equally well constructed with the passenger trains, and, if not travelling at the same speeds, the intervals of departure should be considerable.

"But would it pay to have distinct passenger lines of great speed?

"That must depend on the wealth or commercial importance of the district. If the expenditure in law, land, and compensation were light, lines of double way might be constructed for fast light trains at the rate of 15,000*l.* per mile, including locomotives and rolling stock. As such lines would be independent of communication with other lines, the gauge of 5 ft. 6 in. would be chosen as the now generally acknowledged eligible width. The convenience of man would be studied as the datum line for the construction of the carriages. They would be lofty enough to permit standing upright. They would be 10 feet in width, with a central passage-way for the guard to pass from one end of the train to the other, getting out of the great difficulty of communication between guard and driver. On either side the passage would be enclosed cabins or apartments for four persons each, for passengers wishing to be private; and open saloons would be provided for the gregariously disposed. The seats should be arranged to fold, so that each passenger might sit or stand at pleasure,—an important consideration to induce free circulation of the blood. Arrangements would exist to provide tea and coffee, and similar refreshments while travelling, and also for warming, ventilation, and lighting, and, by fitting construction, easy movement, and absence of oscillation, would enable the traveller to read or write at pleasure. In this mode a constant speed of 50 miles per hour could be maintained without the necessity of the traveller alighting, or injuring his health by swallowing food in too great a hurry, or at too distant intervals of time.

"If we assume a line 100 miles in length, and the cost of it to be 1,500,000*l.*, it would require 75,000*l.* per annum to pay interest at 5 per cent.; or say 206*l.* per diem. Assume maintenance at 10,000*l.* per annum, that would be, say 28*l.* per diem, total 234*l.* The expense of trains would be say 15*l.* each, going and returning a distance of 200 miles, with accommodation for say 150 passengers each train. Four trains each way, with 75 passengers in each, at 1*l.* for 200 miles, or about 1¼*d.* per mile, would maintain the line, and pay 5 per cent. A very small staff and outlay in maintenance of way and rolling stock would suffice for such lines.

"Thus, supposing land at its agricultural value, and law and government expenses *nil*, a high speed railway might be made between London and Liverpool for about 2,500,000*l.* Four high speed trains, with 75 passengers each, going and returning the whole distance, at 2*l.* per head, say 360 miles, would pay all expenses, and give 5 per cent. to the shareholders, and the passengers might go and return the same day within twelve hours, giving an interval of four hours to business. In other words, 2000 annual subscribers of 100*l.*, or 50 journeys per annum each, could maintain such a line for their own use.

"The distance from Calais to Toulon is 600 miles, and the probable cost of a railway promoted by the Government, and the rails and materials furnished from England, without duty, would not exceed 7½ millions. Four high-speed trains per diem each way, or eight trains total, with 95 passengers each, at 2*l.* 10*s.* each way, or 1*d.* per mile per head, would clear all expenses, and give 5 per cent. to the shareholders. And the journey from Calais to Toulon might be performed in less than 14 hours. Making a total of say 18 hours from London to Toulon, and this with no extraordinary fatigue to the passengers.

"On the same principle a high-speed railroad might be constructed from Paris to Irun in Spain for about 5,000,000*l.*, and thence continued to Madrid. Four trains each way, total eight, with 70 passengers in each, at 1*d.* each per mile, would pay all expenses, and give the shareholders 5 per cent., with the distance between Paris and Irun reduced to nine hours.

"Whether this is worth doing now, whether England and France have advanced sufficiently far in civilisation and wealth, and the value of time,—whether it is worth while to bring Madrid within 15 hours distance from Paris, and 23 hours from London, and Cadiz within 30 hours from London, and thus materially diminish the sea distance to Panama as the highway to Australia,—whether it is worth while to bring the orange groves and balmy atmosphere of Southern France within 18 hours of London, now, is simply a question as to the numbers of the wealthy who desire it, but that this will eventually come to pass is no mere problem. It is as sure a thing, sooner or later, as the transit between London and Windsor, or Paris and Versailles.

"At present the question is, are there wealthy capitalists enough in Europe to furnish 8¼ millions of money to shorten the distance between London and Toulon to a day's journey, and 7 millions more to bring Cadiz within 30 hours of London, and travellers enough to pay interest and expenses for speed travelling at from 40 to 50 miles per hour, at 1*d.* per mile. Are there, moreover, men with political power sufficient to overcome commercial hesitation, and willing to write their names on this new scroll of the world's civilisation, rendering distance no bar to the personal communication of the powerful and intelligent throughout Europe."

Of local lines, or communications between neighbouring towns and cities, he thus writes:—

"Such lines properly worked should preserve the equilibrium in the price of labour, and of the necessaries of life throughout the whole community, and would prevent the waste now frequently occurring by the injudicious location of individual operations. They would moreover facilitate the change of employments analagous to each other, and be an industrial school on a large scale. They would break down the distinction between agricultural and mechanical labourers and workmen, and be an insurance against fluctuations of employment.

"They must be rendered more available than at present for the stowage and transport of grain. By establishing air-tight reservoirs of metal, or huge canisters, beneath the surface, grain wagons might run on rails above them and discharge their contents into the openings, which being hermetically sealed, the grain might be preserved for any length of time. Stores could thus be established in desirable situations, ready for transport at a moment's notice, at the minimum of cost, or labour. And such reservoirs, wherein the supply of a nation might be stored if so desired, would require much less proportionate outlay of capital than the ordinary inefficient granaries at present used in which the grain is exposed to damp, vermin of many kinds, and pillage, with a constant cost in manipulation."

Mr. Adams has long advocated the practical conversion of common roads into railways without interfering with ordinary traffic:—

"But by the process of laying down rails of iron on such roads the difficulty is at once overcome, and all such roads may be made available for steam traction, subject only to the question of varying gradients of greater steepness than is common on ordinary railroads. But it would be quite practicable to run engines capable of drawing 30 tons net at ten miles per hour up gradients rising 1 in 25.

"Nor need there be any objection on the score of the rails interfering with the ordinary traffic, because it is quite practicable to sink the rails to the level of the road surface, so that any ordinary vehicles may pass over them in any direction as though the rails were a portion of the ordinary paving. Rails so laid exist in many places where railways cross public highways, and there is no difficulty whatever in constructing a whole line so."

The construction of street lines for omnibuses is also recommended, and the evils of the proposed underground tunnel lines are dwelt on. The City arcade lines are shown to be preferable. But Mr. Adams prefers, for streets of great traffic, the principle of keeping the whole of the street level for the purpose of railways, and covering them in from the highway with glazed lights, making the whole of the shops on the first floor:—

"But supposing it were in contemplation to lay out a new street in a new town, the true plan would be to consider the under surface as entirely belonging to sewers and drains, and quite unfitted for either dwellings or stores. The ground floors should serve for the purpose of stowage, and the street surface should be devoted to the purpose of railways. Above these, at a given height, should be the real street for the shops and dwellings, removed one story from the earth's surface; there would thus be an easy means of getting rid of rain and mud. In fact mud would not exist, because there would be no materials for mud-making above, and transit on rails below would prevent the disintegration of the roadway. The ancient city of Chester had the shops and dwellings raised above the roadway for the sake of security against sudden violence from stranger visitors, and if the inhabitants of our streets could be persuaded to move their shops to the first floor, a much pleasanter promenade would be provided for their customers, and an atmosphere much more conducive to health. Cleaner, lighter, and more elegant shops would thus be attained, and the street would be duplicated. There would be no difficulty in arranging such terraced streets for the transit of light carriages as well as foot passengers."

Agricultural lines are considered, and the very important question of moveable lines to carry manure in and crops off the the ground.

We have found that defects are not merely pointed out by Mr. Adams without providing a remedy. The defective joints of rails are thus spoken of by him:—

"As the inventor of the 'Fish joint,' now so commonly used on railways, the writer has found practically what may be definitely deduced from theory, viz., With the ordinary double-head rails, laid in chairs in the common mode, the strength at the joints is considerably less than at the intermediate portions of the rail, therefore to produce equal strength more metal is introduced at the joints in the form of the 'fishes.' And this amount of metal or more may be economised from the ordinary weight of the rail; thus a rail of 60 lb. per yard with 'fish joints,' will be far more efficient than a rail of 70 lb. per yard without fish joints, by the equalisation of the strength."

A new plan of fixing double T-rails to cross-sleepers is shown by the annexed woodcut, and is thus described:—

"Diagram fig. 1, shows a section and plan of a mode of laying the double-headed rail in common use, so that it is entirely bedded with timber side brackets on the timber sleeper, and it will thus be free from concussion and noise. In the ordinary mode of using this rail, a cast-iron chair or shoe is spiked down to a transverse sleeper of wood. In this chair of iron, the rail is fixed by a lateral wedge of wood, and when so fixed, the top of the rail is raised seven inches above the top of the sleeper. But in the mode of fixing the rail with timber brackets, the lower table of the rail is sunk an inch into the sleeper, and thus the total height of the rail above the sleeper is only four inches, instead of seven, as when used with iron chairs. It is obvious that the more the rail is elevated, the more difficult it is to keep it firm against the lateral blows of the engine and carriage wheels. The advantage, therefore, of the improved mode in lowering the rail nearly one half, must be clear.

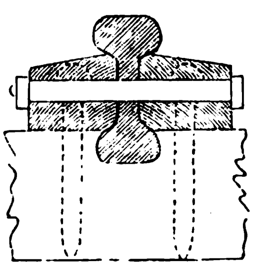


Fig. 1.

"In using cast chairs, which are spiked down to the sleepers, the spikes alone have to sustain all the lateral shocks. In the improved mode, the rail being grooved into the sleepers, takes the lateral resistance directly, and the only use of the spikes is to hold down vertically. This is a source of great safety.

"Again, the grooves for the two rails being cut by machinery, an accurate gauge is obtained and maintained, independently of skilled labour in laying down.

"Again:—The double-headed rail was originally designed for the purpose of reversing, so that, the upper side being too much worn, the lower side might be turned upwards. Practically, it has not served this purpose, because it is so battered and crushed in the cast-iron chairs, as mostly to be useless for any firm fixing in that mode.*

"But by using the rail only with timber fastenings, as shown in the diagram, the rail is in no way damaged, and may be effectually reversed.

"In the mode of using these rails with iron chairs and wood keys, the height and unsteadiness of the rail rapidly crushes and loosens the key, so that it is continually falling out. And this occurring at the joint, is a source of great danger, independently of the occasional fracture of the cast-iron chairs.

"It will be seen on reference to the diagram fig. 1, that two pieces of hard oak, or other timber, about 9 inches in length, and 3½ inches in width and thickness, are bolted by a single bolt through the rail, one in each channel, the lower rib of the rail resting on a cross channel of the transverse sleeper. Spikes are driven through the pieces of oak, into the sleeper, and the whole is secure. If the timber shrinks, the bolt is tightened in its dry condition, and will ever after remain tight At the joints, plates of iron are placed in the rail channels, between the timber brackets and the rail, the same bolts securing the whole. In some cases, in laying new rails in perfect condition, and with hard wood brackets, the joint plates may be dispensed with. If preferred the brackets instead of being in short lengths, may be continuous with the rails.

"In addition to the mechanical advantages, there is a considerable economical saving in maintenance to calculate on from the reduced height and better bedding of the rail. And by reason of the reduced height, a saving in ballast may be effected, and upon the general outlay, taking waste into consideration by breakage of chairs, the saving in laying down a line may be considered as equivalent to the whole value of the cast-iron chairs."

A plain and simple rail, admirably adapted for the United States, Canada, and Australia, and other countries where wood is plentiful, will be readily understood by the woodcut and the following description:—

"Diagram, fig. 2, is a girder rail arranged in the simplest form so as to employ the smallest number of parts, together with the maximum of vertical and lateral stiffness. It may be considered as a single-headed form with a pair of lateral supporting wings superadded at the position of the neutral axis. Two varieties are shown one larger then the other, the respective weights being 60 lb. and 70 lb. per yard, but may be increased to 70 lb. or 80 lb. The upper portion is 2½ inches in height above the sleeper, instead of 7 inches which is the height of the rail used with chairs. The portion below the side bearing wings is the same depth as above, consequently the rail has all the vertical stiffness of the double-headed rail before described, and it has moreover by means of the side bearing wings, a much greater amount of lateral stiffness, still without increasing the quantity of metal. The lower portion is firmly fixed in a vertical groove of the cross sleeper, with the wings bedded therein, and which grooves and bedding being cut by a machine ensure accuracy of gauge. The rail is fastened to the sleeper by one or more spikes or bolts and nuts clipping the edge of the bearing wings. The head or wearing table of this rail is only two inches in width. For transit of the wheels, unless under enormous and not very profitable weights, this is sufficient. The original rails were about 1¾ inch in width, and they were gradually widened to 2½ inches. But this required very much more metal, because as the rails wear down flat, the edges cut away when not supported by sufficient depth of metal. In the example shown, the head is sufficiently wide for the wheels, and of sufficient strength to prevent vertical cutting of the edges, and the two lateral wings give great strength against side shocks. This rail is steadier than fig. 1, and the economy of outlay is equivalent to all the chairs and keys, and one-half the spikes.

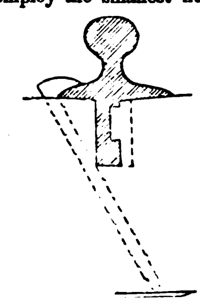


Fig. 2.

"The joints are formed by plates of iron 2½ inches to 3 inches in depth, bearing in a lateral groove of the lower part of the rail, and against the wing above, being secured by two bolts, one at each end, passing through rail and plate; the rail and joint plate being forced into the vertical groove of the sleeper, and, held down, the whole is firm.

The following explains a girder rail well adapted for countries where wood is scarce:—

"Diagram fig. 3, shows a girder rail, weighing from 115 to 120 lb. per yard, well suited to this purpose. With angle cheek plates bolted to the rails to connect the joints, and tie-bars to secure the gauge, this rail would serve very well for moderate rates of speed, and would keep in good condition in a hot climate. But when iron is at a high price it presents a difficulty in the construction of such lines. It must be remembered, however, that no other material is required. As the horizontal portion of this rail would not be damaged by occasional flaws in the edges or thin parts, it would not involve many 'wasters in the process' of manufacture."

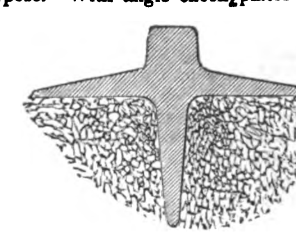


Fig. 3.

We recommend all those who are connected with railways carefully to study this publication, which contains the essential considerations how to make railways useful to the public in the widest sense, and most profitable to the shareholders.

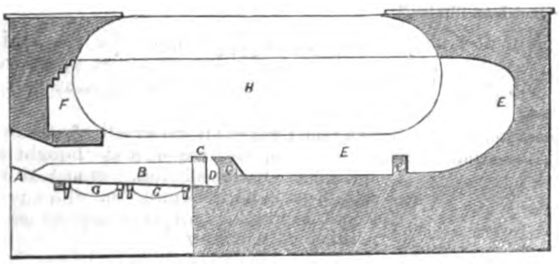
* "But in many cases, these damaged rails, unfitted for cast chairs, may be turned to account by securing them with the wood brackets. The side channels of the rails are generally unaltered in form, and to them the brackets can at any time be fastened, and the grooves in the sleepers may be cut to any form the table of the rail has taken. In this mode, several years' further work might be taken out of the rails, and the value of the old chairs might help to pay for the improvement."

## FURNACE FLUES.

BENJAMIN PRICE, *Patentee*, February 25, 1853.

IN describing his invention, the patentee says, in the first place, there is no complicated machinery, consequently no anxiety as to the probability of such being put out of order, the principle of the invention consisting in the construction of the flues, which are provided with large circulating chambers, where the various gases receive the current of air which passes through the tube B, and which is carried through the furnace; the effect

FIG. 1.



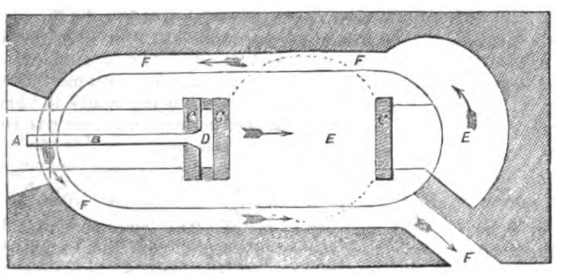
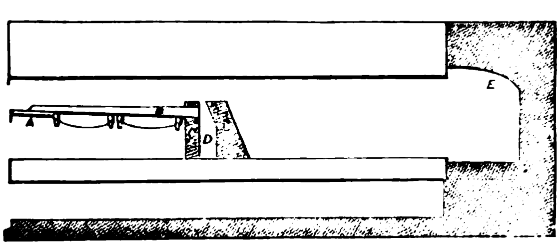


FIG. 2.

of which is, the air becomes rarefied, and the chambers supplied with the required quantity of oxygen to produce the most perfect combustion. The action of the heat is more regular than upon any other principle, and the boilers, &c., of whatever description, not so liable to destruction from caloric action. Another important feature is the saving of fuel: a furnace constructed upon any ordinary principle consumes, say, twelve tons of coals in a certain specified time; a more satisfactory result at a more uniform rate will be obtained by using nine tons, or even eight tons, upon this improved patented principle, thus showing a saving of from 25 to 30 per cent.

FIG. 3.



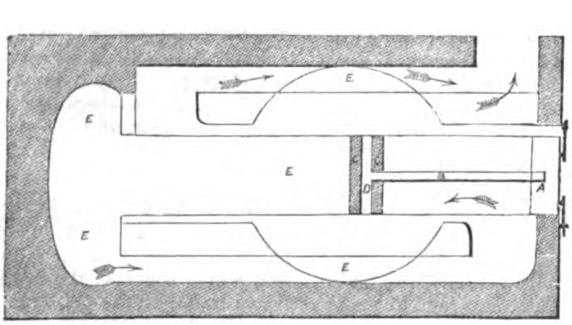


FIG. 4.

Fig. 1 of the annexed engravings represents a longitudinal section of a boiler and furnace built in accordance with this invention; fig. 2 a sectional plan of the same; fig. 3 (a longitudinal section) represents a modification of this furnace, with a different arrangement of the flues; and fig. 4 a sectional plan of the same. A, is the dead plate of the furnace; B, a tube, which passes from the mouth of the furnace through the first of the bridges C, C, C, and is connected with a hot-air chamber D. This chamber D, communicates with the circulating chambers E, E, and is constantly supplied by the pipe B, with a current of hot air, which being distributed through the chambers E, E, and mixing with the smoke and gases contained therein, insures their perfect combustion, and thereby effects considerable saving of fuel. F, F, F, are the flues; G, the furnace-bars; and H, the boiler.

## ON THE SEWAGE OF GLASGOW.

ON account of the great number and variety of chemical works in Glasgow which empty their refuse into the sewers, the contents of the sewers differ widely one from the other, and the sewage of some of them changes its character almost hourly; hence the treatment of sewage by precipitation in tanks near the mouths of the sewers becomes impossible, as no precipitant will answer for any two sewers, or for the same sewer at different times of the day. The sewage nuisance is become most intolerable and deadly in Glasgow; the river is in parts covered with a filthy yeasty foam, and in summer the " noisome reek" from the water, when stirred up by the paddles of the steam-vessels, often cause the passengers by these vessels to become exceedingly sick and ill.

In conformity with Lord Palmerston's recommendations, in his letter to the Synod of the Church of Scotland, the city authorities of Glasgow and the Clyde Trust Committee, with their excellent officers, Messrs. Carrick and Eure, have been anxiously endeavouring to remedy this crying evil, which threatens so seriously to interfere with the commercial prosperity of the city. We copy the following from the *North British Daily Mail* :—

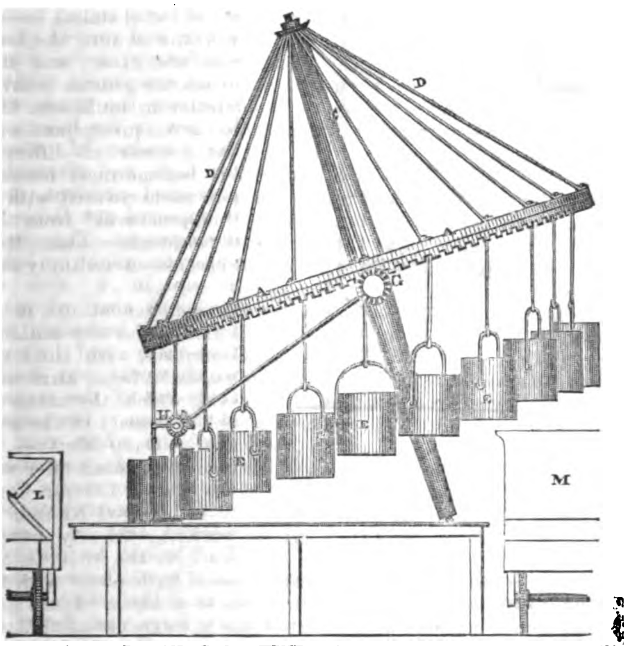
" It will be in the recollection of our readers that an offer was recently proposed for the acceptance of the Statute Labour Committee of Police, by Mr. Smith, whereby he pledged himself to enhance the amenities of the Clyde by purifying the city sewage, on the condition that the corporation gave him the title to the manure for the next 14 years. This proposal to do away with the pestiferous impurities which have so long been matter of just complaint by the citizens, without involving any expense to the corporation, was so fair and reasonable that a public test of the plan by which it was to be carried into effect was only wanted to secure its acquiescence. This desideratum was supplied lately on the river side, immediately opposite the foot of Dixon-street. Mr. Bardwell, of London, the patentee, attended personally to superintend the experiments. The process of purification as exhibited on this occasion, was exceedingly simple. The water operated upon was taken from St. Enoch's Burn by means of pipes, and being pumped up with a slight fall it ran down through a filter-bed, and thence was carried off by a common rhone. The filtering media consists of iron scoria, charcoal, and sand, which retain the filth, leaving the water as pure as that to be found in domestic use in many of the private dwelling-houses on the north side of the river. Although it was sufficiently clear for all practical purposes, the water could be made much purer by thickening the filter bed, which, however, would retard its exit, No offensive smell is raised by the process, a perforated bed on the top of the apparatus strewn with charcoal absorbing all the noxious effluvia thrown off by the residuum, which is very valuable for agricultural purposes, being a rich manure. As a matter of course the experiment was conducted on a small scale; but we understand that a filter of 60 feet square would be capable of purifying 5,000,000 gallons of water per diem. Were the plan adopted in this city the sewage of a particular district would be taken up first and purified in a grand centre filter communicating with all the drains in the locality. The gentlemen present all expressed their unqualified satisfaction at the result of the experiment, which was highly successful. Now that the authorities have witnessed the practicability of a scheme, whereby the great generator of disease in our city may be effectually abolished, we hope that they will enter into arrangements with promptitude and vigour for having it tried on some of the great sewers—at the Bridge of Sighs for example."

## IMPROVED COKING CRANE FOR SUPPLYING LOCOMOTIVE ENGINES.

By John Ramsbottom, of Manchester.

*[Paper read at the Institution of Mechanical Engineers.]*

This coking crane was designed by the writer about two years ago, in consequence of the great wear and tear of coke skips used for coking engines, at the Manchester station of the London and North-Western Railway, and the necessity that more particularly existed for coking the engines in the least possible time, owing to the limited space there was then for the traffic. The crane is shown in the annexed engraving, and consists essentially of a large wheel or circular rim 20 feet in diameter, made of iron segments A, A, having arms B, B, 20 in number, which may be considered to be the jibs of so many small cranes. These are




mounted upon one common post or pillar C, C, which revolves upon bearings at top and bottom, and each arm or jib is tied by a rod D, D, to a hollow cast-iron cone, which is fastened upon the top of the pillar, and is adjusted by means of a screw and nuts. In fact, the whole may be considered, so to speak, as twenty small cranes working from one common centre. Around the circumference of the rim are suspended, at equal distances, twenty wrought-iron cylindrical buckets E, E, 2 ft. 6 in. diameter, and 2 ft. 8 in. deep. Each bucket is fitted with a bow handle and swivels, so as to be readily turned over when its load is to be discharged. The segments A, A, are also provided with teeth upon the lower edge, which gear into a pinion G, and the movement is carried forward to the handle H, by means of the two pairs of bevil wheels, and in such proportion as to give 115 revolutions of the handle for one of the crane. The chief peculiarity, however, consists in the main post being fixed in an inclined position. This is done to such an extent as to throw one side of the rim 6 feet higher than the other, and it will be seen from the drawing that the buckets on one side are sufficiently low to be filled direct from the wagon L, and on the other sufficiently high to deliver their loads upon the tender M. The buckets hold in the aggregate 3 tons of coke, so that the crane will carry, ready for delivery at a moment's notice, sufficient coke to supply three passenger or two goods engines at least. Of course, when the crane is fully loaded, the whole is in equilibrium, and it can then be moved by a force sufficient to overcome the friction only; on the other hand, the greatest power is required when the buckets are empty on the descending side, and full on the other. The proportion given, however, will enable one man to work it under the worst circumstances.

In using this crane, the practice is to keep the buckets full as far as circumstances will allow, and any engine requiring coke has the tender backed under the higher edge of the crane; the coke-man then turns the crane round by the handle previously described, and continues to do so until the fireman or other person has turned over as many buckets of coke as are required. The time rarely exceeds two minutes for the delivery of 21 cwt. of coke, and is often less.

As respects the saving of labour, it may be mentioned that four men were formerly required to deliver coke at this station, and it is now delivered by two, and the skips are dispensed with.

The fact that this little machine has worked very satisfactorily during the last two years induced the writer to bring it before the meeting. It evidently possesses the advantage of carrying a considerable quantity of coke ready for immediate delivery, and of elevating, advancing, discharging, returning, and lowering the buckets by one simple movement.

There is one slight drawback, however, namely, that an engine cannot run past it, owing to the chimney; but where this is considered necessary, the crane may readily be fixed about 3 feet further from the rails, and the coke delivered by a moveable shoot.

*Discussion.*—Mr. Beyer (the Chairman) observed, that he had seen the coking crane described in the paper, and thought it a very simple and efficient plan; the one objection that had been named, of not leaving space for passing along the line by the side of the crane, might probably be remedied in several ways if required in another situation.

Mr. Ramsbottom said that object had not been thought of at all in the present case, as it was at the termination of the line, where it could not be extended beyond the crane, and that was the only one on the plan at present tried. The crane had been found very convenient for use, as it required very little power to work it, and held a large store of coke always ready for loading the tenders; it had been in constant work for more than two years, with scarcely any expense for repairs.

Mr. Cowper thought the crane was well contrived for the purpose, and suggested that it might readily be made applicable to a situation where a clear passage was required on the line past the crane by omitting a portion of the buckets on one side, perhaps one-third, which would always allow the passage of a train, when the blank side was turned towards the line; the same quantity of coke might be carried by increasing the size of the buckets or the diameter of the crane. He thought that a perfect coking crane should, if possible, be balanced in all positions, for the engineman to be able to pull it round by hand, and take in a supply of coke without requiring a second man to help; on the same principle as the present large 8-inch water cranes which supplied the water with great rapidity without help. This might be accomplished by working the crane round on a level instead of inclined, so as to be always balanced, and lifting the coke up previously to the level by other means.

Mr. Woodhouse thought there would be a difficulty in raising the coke by other means, and the oblique crane which he had frequently seen at work was a very convenient mode of gradually raising the coke by the same movement as changing the buckets. In some places the coke was raised up at once from the wagons to a high platform, and then loaded into the tenders by a shoot; but that plan was not so convenient for measuring the coke as the crane with buckets holding exactly 3 cwt. each.

Mr. Ramsbottom observed that the average height the coke had to be lifted in loading the tenders was only 3 feet, as the coke was already lifted an average of 3 feet, or half the total height 6 feet, in the process of filling the buckets all round.

Mr. Cowper suggested that each bucket when loaded on the platform might be slung up or raised by a small windlass, and then hooked on to the crane at the upper level.

Mr. Ramsbottom observed, it would certainly store up more power ready for coking the tenders, if all the coke were previously lifted up to the full height 6 feet, instead of an average of only half the height; but the simplicity of the machine would be somewhat interfered with.

Mr. Downing remarked that there might be room to pass the crane by fixing it a little farther from the line, and tipping the buckets over the side of the tender; there being no necessity he supposed to empty over the centre of the tender.

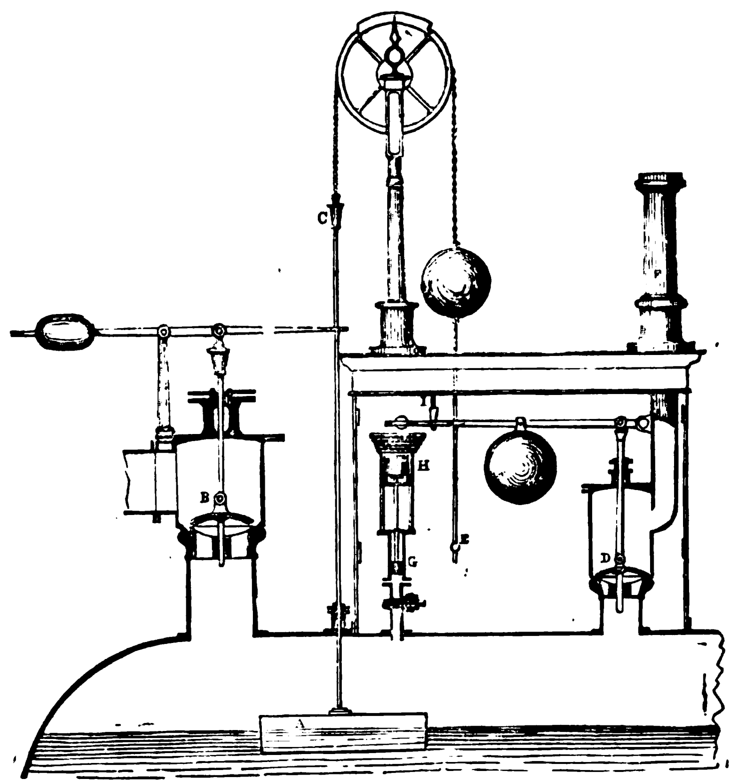
Mr. Lloyd suggested an octagon form for the purpose instead of a circle; he thought the same plan of crane would suit well for filling blast furnaces, where, as in Wales, there was not more than 6 feet to lift the materials in many cases.

## APPARATUS FOR PREVENTING EXPLOSIONS OF STEAM-BOILERS.

By John Rolinson, of Brierley-hill.

[*Paper read at the Institution of Mechanical Engineers.*]

The object of this apparatus is to provide a self-acting means of closing the stop-valve, and opening the safety-valve, when a boiler is getting short of water, thereby cutting off all communication with the other boilers until the boiler is again properly supplied with water, and causing an alarm to call the attention of the engineman, before the water has got so low as to risk any injury of the boiler, preventing at the same time any increase of the pressure in the boiler.




Our engraving is a longitudinal section of the apparatus. The float A, falls when the water gets low in the boiler, and closes the stop-valve B, by the tappet C, and opens the safety-valve D, by the tappet E, causing an alarm by the rush of steam through the escape-pipe F, as soon as the water gets down to the level to which the apparatus is adjusted, without the use of a whistle.

In a range of boilers working in connection, it sometimes occurs, from various accidental causes, that one of them becomes low in the water, causing danger of explosion, but with this apparatus such an accident is prevented; and by closing the stop-valve and opening the escape-valve, the boiler is cut off, and prevented from causing accident until properly filled with water again, when it resumes its former position, as the stop-valve then opens again and the escape-valve closes.

The pressure of steam is prevented from ever getting too high in the boiler by the small cylinder G, with a piston one square inch area, which is open to the boiler on the underside, and is loaded on the top of the piston-rod at H, with as many pounds weight as the number of pounds pressure per square inch intended for the limit of the steam pressure. The piston lifts these weights in succession as the pressure rises, and at last lifts the lever of the escape-valve D; a space is left between the different weights, so that the piston has to move nearly to the top of the cylinder before it comes to the full pressure, and by the continual movement of the piston in the cylinder from the variations of pressure in the boiler, the piston is prevented from sticking fast, and is kept always ready for action.

The escape-valve lever is held up by the spring catch I, if it continues to be lifted beyond a certain point, and then the escape of steam cannot be stopped, and the alarm will continue sounding until the engineman, returning to his duty, releases the valve lever from the catch, by pulling the handle K.

The whole apparatus is locked up in one cast-iron box, so that the engineman is unable to increase the steam pressure, or to prevent the sounding of the alarm and the escape of the steam whenever the water level is suffered to get too low from any cause, or the steam pressure gets too high. The apparatus is connected to the ordinary stop-valve fixed usually on boilers, and requiring only an alteration of the lever.

This apparatus has been at work for about two months at Mr. Benjamin Gibbons', Corbyn's Hall, New Furnaces, near Dudley, and has proved quite satisfactory. It has been tried fully by blowing off the water from the boiler down to the level to which the apparatus was adjusted, when it was always found to act completely, and also when the pressure of the steam was raised too high.

Mr. Gibbons said that the apparatus described in the paper was applied to a boiler 6 feet diameter and 30 feet long, one of a set of three boilers at his works, and proved quite satisfactory; it was found to act completely, either whenever the water was too low in the boiler, or the pressure of steam too high, and effectually prevented accident, and it appeared not liable to derangement. The whole apparatus might be locked up in a case of moderate size, about 3 feet high, including the float-chain and wheel, which would put it entirely out of the control of the men. He added, that the whole cost of the apparatus was about 15*l.* or 20*l.*

Mr. Ramsbottom remarked that a heavy float would be required to insure the action of the apparatus, and it would have to close the stop-valve against the pressure of steam in the boiler.

Mr. Rolinson said the float was made large and heavy to insure certainty of action; but the steam from the other boilers would be always pressing on the top side of the stop-valve, and the pressure in the boiler on the under side of the valve was lowered by the steam being let off directly the apparatus acted.

## MONKLAND SCHOOLS, NEAR LEOMINSTER.

(*With an Engraving, Plate* III.)

The schools are situated in a picturesque spot, on the river Arrow, near Leominster. They are erected from the designs of Mr. John Hicks, architect, Dorchester, on glebe land adjoining the churchyard, and will form with the church, when restored, of which great hopes are entertained, a very pleasing object, and be a great improvement to the parish. The land was given by the rector, by whose exertions the necessary funds were raised, including grants from the National Society and Committee of Privy Council. The cost of erection, including fittings, desks, &c., amounts to 400*l.*

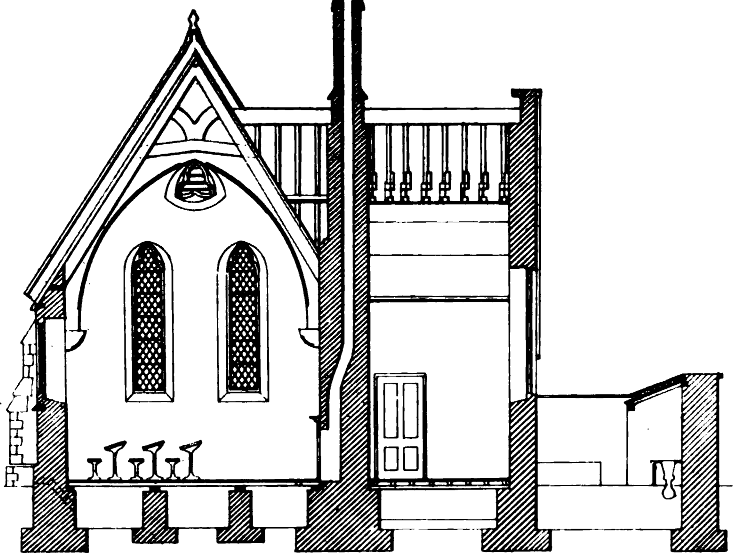
The building is of sandstone rubble-work (new red), with Bath stone dressings, from Messrs. Randell and Saunders' quarries. The roof is open timbered of stained memel, and plastered between the rafters, and covered with plain tile of the neighbourhood, the colour of which, whilst new, is objectionable, but they were used for the sake of economy, Broseley tiles being specified. The schoolrooms are ventilated, and the class-room warmed, by means of a chamber in the back of the open fireplace or stove-grate in the schoolroom, and fresh warmed air by this arrangement is constantly supplied. Accommodation for fifty children is provided; the school is mixed.

# MONKLAND SCHOOLS.

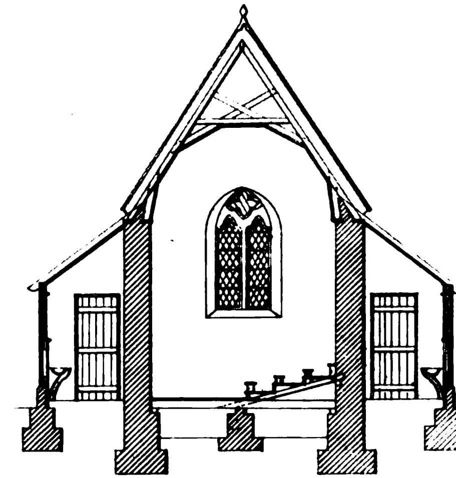
Near Leominster.

J. Hicks, Arch^t

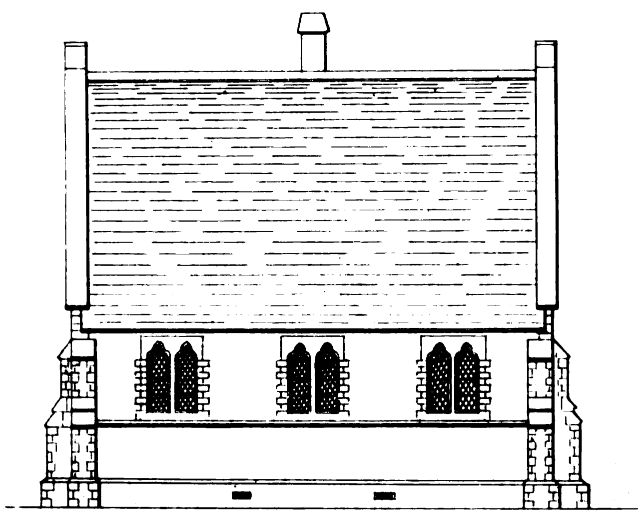
Front Elevation.



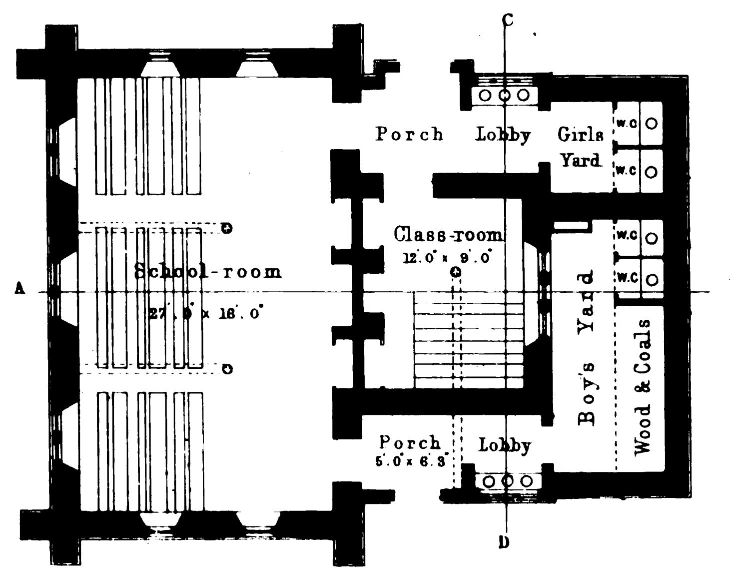
Section on the line A.B of Plan.



Section on the line C.D of Plan.



End Elevation




Plan.

SCALE.

0 5 10 20 30 40 50 Feet

J. R. Jobbins

## TRADE SCHOOLS.*

Not very long ago we made some remarks on the subject of industrial education, and now we have before us evidence of progress. The Rev. Henry Moseley, one of the Inspectors of Schools, is a canon of Bristol, and he has therefore been called upon by the Committee of the Bristol Diocesan School to consider the best means of giving efficiency to that establishment. So far as we understand, it was originally designed as an elementary school, but the progress of the national schools has to some extent superseded it; and Mr. Moseley proposes, therefore, as it was established for the benefit of education generally in Bristol, to make it supplementary to the elementary schools, and to establish it as the British Trade and Navigation School.

It is suggested, that as in the national schools there are some boys in advance of the rest, and capable of receiving instruction of a higher kind, that there should be offered to them a special course of instruction of *a practical kind*, having reference to the mechanical and manufacturing callings, and the trade of Bristol.

To determine the specific objects to which such a course should be directed, Mr. Moseley referred to the Bristol Directory, and counted up the number of manufacturers, tradesmen, and master workmen, the principles of whose manufacturing or mechanical pursuits or trades require, to be thoroughly understood, a knowledge of certain elementary principles of science. This list was divided into three groups.

The first group Mr. Moseley appropriates to the trades, eighteen in number, which are connected with building. This branch includes 750 tradesmen in the city, besides journeymen. Mr. Moseley observes that the department of school instruction adapted to youths intended for any of the trades composing it, will be understood by a reference to the 'Builder's Price Book.' He considers that youths might, at such a school, be thoroughly familiarised with measuring, and made to acquire facility, precision, and accuracy in all the various calculations referred to in that book, and might further be made to comprehend the principles on which those calculations are founded. Undoubtedly, this is a department of applied or special arithmetic, particularly useful for such a class, and which can be taught by any decent teacher of arithmetic.

The Inspector proposes, in addition, that the lads shall be instructed in levelling, geometrical drawing, in taking plans, and in those principles of experimental science which are connected with ventilation and sewerage, and with the lighting and heating of buildings. With regard to the levelling—although, if there were the opportunity, that might be taught—there are few classes of mechanics to whom it would be immediately useful. Geometrical drawing and taking plans are, however, of general utility; but the inspector has missed a branch of drawing which is particularly useful to every class of mechanics, and that is general drawing. For the building trades, modelling and the making of models may likewise be advantageously taught. Geometry on the French system should be an especial element in the course. The principles of experimental and applied science form another essential, and we presume that the lads will have access to the department of chemistry attached to Group C, though Mr. Moseley does not make mention of this circumstance.

Mr. Moseley considers, that with such a course the youths could not fail to enter on the building trades with great advantage to themselves and to the public, as compared with other persons who have received no such previous instruction. In this, we apprehend the profession will concur with him, for as the classes are to be opened to the sons of masters and journeymen, the result must be a better trained class of assistants in the building trades, competent to carry out the views and instructions of architects. It is to be noted, that as this is a preliminary or subsidiary course, the practical training in the workshop, which is so important, will not be interfered with.

Mr. Moseley's second Group B, contains seventy-two trades, giving occupation to 600 manufacturers and tradesmen, and these he ranges under the general description of mechanical pursuits; but he only briefly says that they require, in order that the principles on which they depend may be understood, an elementary knowledge of mechanism and of the science of practical mechanics. We should say that the instruction should further embrace drawing in the necessary branches, geometry, applied arithmetic, and chemistry.

His third Group includes sixty-two trades or manufactures, giving occupation to 358 manufacturers or tradesmen, dependent upon the experimental sciences, and more particularly upon chemistry, of which he says that each is, in fact, little more than an application. Nevertheless, in this department we recommend a general instruction in mathematics and in drawing.

A department specially requisite in a seaport like Bristol is a school of navigation, and we lament to say, that until the new Act the only schools of navigation in England were Christ's Hospital and Greenwich; but now the Marine Department have established schools in London and Liverpool, in the former of which are 300 pupils, and in the latter 200 pupils.

We consider it a defect in Mr. Moseley's scheme that there is no provision for the department of practical ornament or art. It may be that he considers this as belonging to the school of design; but when we look to the age of his pupils, and the desirability of constituting the schools of design as advanced and practical schools, it must be held desirable to prepare pupils for the superior instruction of the schools of design. What is called geometrical drawing—which is a great favourite with schoolmasters and theorists—is, when made the sole or chief branch of instruction in design, a most mischievous instrument of education. It substitutes certain conventional mathematical types for the grander geometry of nature. It injures the training of the eye, and restrains the artistic development, while it does not assist the mechanic.

Mr. Moseley takes a very moderate view of the benefit of the scheme proposed. He does not even allege that a knowledge of these various branches of science is necessary for carrying on the different trades which have been enumerated. He dwells, however, on the consideration, that if carried on in ignorance of such branches of science, they are carried on in ignorance of the principles on which they rest; and that whoever so carries them on misses that opportunity for the improvement of his mind, which is supplied by the daily habit of reasoning on and understanding what he is about; that he misses one of the highest pleasures of which the mind of man is capable—that of thus reasoning and understanding; and that he is wanting in that which is a legitimate source of moral dignity and self-respect. He relies upon it, that, taken collectively, these trades cannot but suffer, in a commercial point of view, from an ignorance on the part of those who carry them on, of the principles on which they depend, an assertion which every professional man will confirm. He says, further, that it is impossible but that new and improved processes of art and manufacture, and expedients of construction, should result from such knowledge; nor can any one doubt this who knows the many improvements which are constantly made by our manufacturers and mechanics.

Speaking of the value of a navigation school, the Inspector fails not to point out how the boys of the Royal Naval School at Greenwich having received previous instruction in the theory and practice of nautical science, are, when they go to sea, greatly benefitted by it; not only in this, that when they rise (as many of them do) to be mates and masters of merchant ships, they navigate those ships better than they otherwise would; but that whilst they are still sailors, they are better and more efficient sailors than they otherwise would be, and more contented and willing to undergo the hardships of a seafaring life. Mr. Moseley might have strengthened this by reference to the like department in Christ's Hospital. The experience of practical men in every department is in favour of these views. Without pointing to the many brilliant examples known to all of us, of men who have risen to the highest ranks from the working classes, there is not a workman who has not observed how his self-taught shopmate has benefitted by the proper application of his evening hours. It is to the recognition of this fact that the numerous mechanics' institutions and mutual instruction classes owe their foundation.

By the scheme as devised by Mr. Moseley, the requisite funds will be obtained from the existing endowments, from a grant through Dr. Lyon Playfair from the Practical Department of the Board of Trade, from the Marine Department, and from the Council of Education. The permanent masters will be two, at moderate salaries. These will be trained schoolmasters, one of whom is to have a general knowledge of experimental science and of practical mechanics, and the other to teach the navigation, mathematical, and mechanical drawing classes. A young architect or surveyor will be employed to give technological knowledge

* 'Trade Schools: A Letter to the Committee of the Bristol Diocesan School.' By the Rev. Henry Moseley, M.A., F.R.S., Canon of Bristol, one of Her Majesty's Inspectors of Schools. Bristol: Taylor. 1858.

to Class A; and occasional assistance of the like kind will be obtained from mechanics or other competent persons. A young engineer will be found very useful in Class C. There are very many young professional men, biding their time, who will be glad, for a very moderate fee, to give the required occasional instruction, looking to the office as one of honour and practice, and not of emolument. The charge to the boys is very properly fixed at a very moderate rate—sixpence per week for the sons of workmen and chamber masters, and one shilling per week for the sons of persons above that grade. Facilities will be given, under certain circumstances, to attend during only one-half of the day, and hereafter evening classes will be established. It is held out that pupil teachers will be appointed by government endowment, and encouragement be given to national school scholars by giving them exhibitions of 1*l.* a year in the trade school. We are glad to see the school establishment is put on a moderate scale, and we sincerely hope the experiment will be encouraged, and prove successful.

## APPLICATION OF PAINTED GLASS TO BUILDINGS IN VARIOUS STYLES OF ARCHITECTURE.

By Charles Winston.

[*Read at the Royal Institute of British Architects, Nov. 28th*, 1853.]

In composing this paper on Painted Glass with reference to its employment in buildings in various styles of architecture, I have endeavoured as much as possible to keep in mind the practical objects of this Society. Many matters, therefore, of interest to the antiquary will be passed unnoticed, or with a brief allusion to them—my object being, as far as I am able, to supply an answer to the question, What is the kind of painted glass best suited to a building of a given character?

On a question so wide and complicated, it is not only natural that very different opinions should exist, but extremely difficult to ascertain which is the most correct. The inadequacy of language to express ideas so subtle as those of which questions of taste are composed, must ever be an insuperable obstacle to bringing questions of taste to a certain determination by argument; a consideration which is condemnatory of the modern vice of dogmatising upon such subjects. And the nature of the only remaining tribunal—the concurrent opinion of men of taste—that is, of men who have given their attention to such matters, and whose views are respected by others engaged in the same pursuits—of itself sanctions a great latitude of sentiment. The feelings and habits, the education and temperament of individuals, even their natural appreciation of form or colour, all insensibly influencing their opinions on a subject respecting which there exists no definite standard. I am therefore very far from claiming any sort of infallibility for the views I am about to submit to your consideration—views which I shall attempt to support rather by calling your attention to objects with which you are already familiar, than by elaborate argument.

The variety of buildings which may require to be decorated with painted glass is great. Some are in the Greek or Palladian styles of architecture, others are in the Gothic styles; and each building may be more or less grave or solemn in its aspect than others of its class. Such differences in the buildings demand of course corresponding differences in their painted windows. But before entering upon this topic, it will be convenient to declare what I believe to be the best subjects for glass painting, and the best mode of executing them. With regard to the mode of executing glass paintings, I will recall your attention to a paper which I read here about a year ago, on the Methods of Painting upon Glass.[1] In which, after stating that there were three distinct modes of executing glass paintings—viz., by the *mosaic* method, in which the local colouring of the picture is produced by means of glass coloured in its manufacture, the shadows and outlines only being executed with an enamel colour; by the *enamel* method, in which the colouring of the design is effected by using enamel colours; and by the *mosaic enamel* method, by which the colouring of the picture is produced by a combination of the two former methods,—I concluded that the mosaic method was the best, because it was, from the nature of the thing, more favourable than either of the others to a display of the translucent quality of glass, and consequently of its brilliant and powerful colours; whilst, at the same time, it afforded the means of executing works as highly pictorial as the windows of the transepts and north chapel of Brussels Cathedral—works which maintain their superiority in point of effect when compared with a series of later examples, including some of the most beautiful specimens that modern continental art can boast. This conclusion—for the soundness of which I must refer you to the paper I have named, and to the works of art therein mentioned—will confine our inquiry to what are the subjects best adapted for representation in glass paintings, executed according to the mosaic method.

These subjects may be divided into the following classes:—Patterns, similar to those used throughout the mediæval period, and which usually consist of ornamental work in white glass, but sometimes of scrolls of foliage, either white or coloured, on a coloured ground. Pictures, where the objects are represented as seen in one plane, as in a bas-relief—such as we see in the painted windows of the 12th and 13th centuries; and pictures, where the objects are represented as occupying several planes, as in nature—such as we meet with in the painted windows of the first half of the 16th century; and, of course, compositions consisting entirely of such patterns or pictures, or partly of patterns and partly of pictures. To avoid any possible misconception, I should perhaps here state, that any reference to mediæval examples in this paper is made only for the purpose of illustration, and not with any intention of conveying any impression that they are fit objects of imitation. Most valuable hints are doubtless to be obtained from an enlightened examination of such examples; but before we think of copying them, we ought to be quite sure that they are worth copying; and I will undertake to say, that not one ancient example of painted glass, except, perhaps, those consisting of pattern work, can be considered as a perfect model for imitation. All, with the trifling exceptions I have named, of whatever date, are defective in one way or another, either in composition, drawing, or general effect. Even the finest cinque cento examples, which, taken collectively, are perhaps of all ancient examples the least open to criticism, were done at a time when the human figure was but imperfectly understood by the glass painters. And with regard to the often-expressed notion, that it is better to submit to copies of mediæval examples than trust to modern invention, permit me to say, that a more unjust imputation against the taste and skill of the 19th century never was made, or a more complete apology conceived for indolence and incapacity. Whose fault is it, I would ask, that low art, at least in regard to glass painting, should seem to be almost inseparably associated with what are called church principles of architecture? Are not the patrons of the art to blame for indolently acquiescing in and sanctioning a mere system of copying, because they have not sufficient energy to study glass painting thoroughly, and make themselves acquainted with its principles? We may depend on it, if glass painting, or I may say art in general, had a practical bearing on the affairs of life, instead of only furnishing a means of amusement, we should no more hear of currency being given to such doctrines respecting it, than we now hear engineers advocating our going back to the single-condensing steam-engine, or travellers by railway yearning for a return to the old horse-tracks.

The patterns to which I have alluded do obviously comply with the conditions of the mosaic method in the fullest and simplest manner; for the brilliancy of the glass is altogether unsubdued in these works, and the mechanical construction of the window is in harmony with their design—the leadwork connecting the pieces of glass either forming an integral part of the pattern, or else actually constituting the pattern itself. I may illustrate my meaning by a reference to familiar examples, such as the Five Sisters at York, and the geometrical pattern works, executed in white glass, so common in the 17th century, particularly on the continent.

Turning from these, the works which next appear the most completely and simply to comply with the conditions of the mosaic method are the pictures of the 12th and 13th centuries; for, of all pictures, these admit of the employment of glass of the most powerful hue, and the least diminish its brilliancy. Here, also the leadwork is made conducive to the effect of the design. It is true, that in the cinquecento style we meet with pictures in which, as in a bas-relief, all objects are represented as occupying one plane as effectively as in a picture of the earlier period; but in no glass paintings is the bas-relief principle of representation effectively carried out with so much *simplicity* as in

[1] See *Journal*, Vol. XVI. 1853, p. 190.

the pictures of the 12th and 13th centuries. This, I apprehend, is owing no less to the nature of the glass of which these works are formed, than to the composition of the picture. This glass, when compared with the glass used in later times, is remarkable for its apparent solidity—a quality which, without sensibly detracting from the brilliancy of the glass, imparts great depth and richness to its hues. Hence the artists of that early period were able to leave large breadths of glass in their pictures unincumbered with any enamel colour—with which, in the mosaic style, as I have already informed you, the painting of the picture is performed—without incurring the risk of producing a weak or flimsy effect. We all are aware of the fact, that the shields of arms and the panel grounds, which in later years were so profusely adorned with diaper patterns, executed with the enamel brown paint, are in the works of this period usually left quite plain—the artists appearing to rely for effect on the tone and richness of the material itself. So we perceive, on examining a figure in any one of these early pictures, that whilst the deepest shadows are represented in the simplest manner by opaque lines, and the shadows in half-tint by a slight wash of enamel brown, the proportion of the glass left quite clear for the high lights is much larger than in later glass paintings. That such a simple mode of execution, if applied to a more pellucid and watery material, must necessarily produce only a poor and flimsy effect, may be learnt from the modern copies of 13th century glass. But without dwelling on this point, I will call your attention to the composition of a 12th or 13th century picture, as of itself insuring distinctness without the aid of any great breadth of shadow. This is simple enough: it consists in arranging the figures in one line, usually on a bar crossing the picture; in keeping the action of the figures as much as possible in the direction of the plane of the picture, and in insulating and separating the figures by the ground of the picture—a treatment, as you perceive, corresponding with that of an antique bas-relief. And since this treatment is in general more intelligibly carried out in the earlier examples, I think we may venture to ascribe it to the fuller influence of classical art at an early period of glass painting. In addition to this, as a general rule, the colouring of the figures is kept lighter than that of the ground of the panel. Of course these remarks are derived from an examination of a great many examples. I mention this because I could easily contradict almost every one of them by a reference to particular works. It is from a majority of specimens only that a general principle is to be collected. The subjects to which I have just alluded are necessarily characterised by a certain archaic formality, arising from the stiffness of the colouring, and the simplicity of the design and execution.

I have now to direct your attention to subjects of another class, as remarkable for their pictorial effect. I mean the picture glass paintings of the first half, or more correctly, of the second quarter of the 16th century. These works are in many respects the very opposites to those just described. Their colouring is harmonious rather than deep, and they are highly finished—peculiarities which I could show to be connected with the nature of the glass employed in these works, which, without being as flimsy and pellucid as ordinary modern glass, is yet very inferior in depth and richness to that of the 12th and 13th centuries. Still these works will be found to comply with the conditions of the mosaic method, after making allowance for their different nature, equally with the works of the 12th and 13th centuries; and I hope I shall be able to prove that they are entitled to equal estimation. Their composition is various, consisting sometimes, as in the pictures of the 12th and 13th centuries, only of a line of figures occupying a single plane; but more commonly of a group—of *foreground* figures, it is true, but which in parts recede from the eye; the figures not unfrequently occupying in plan, the arc of a semicircle, as in some of Raphael's designs; and beyond the figures some distant object is usually represented, such as the sky, or a landscape. The picture, therefore, is designed on the principle of representing depth, and, in the best examples, is executed in such a manner as to produce the effect of depth. The means resorted to for this purpose are very simple. First may be noticed, the choice of such subjects as are capable, without a violation of probability, of being represented in a somewhat severe, if not harsh manner: thus a landscape, or a sea piece, a full idea of which cannot be conveyed without representing the graduated tints and soft outlines of nature, was never, at this period, selected as the *principal* subject of a glass painting. On the contrary, when a landscape background is adopted, it is used merely as an accessory, to set off and relieve a group of foreground figures, in which all the interest of the composition centres. And, secondly, we may remark, that all the objects in the picture are represented as if they were seen under the influence of broad sunshine—a mode of treatment the most favourable, not only to a display of bright lights and sharp decided shadows, but to the general transparency of the picture, it being possible by this means to separate the various objects from each other, without having recourse to extensive masses of shadow or concentration of light, the use of which, however effective in the works of Rembrandt and other oil painters, is wholly unsuited to the conditions of glass painting, on account of its very limited scale of transparent shade. The heaviness resulting from the adoption of the opposite principle, of concentrating the light in the middle of the picture and keeping the rest in comparative obscurity, is shown in the upper subject of the west window of New College Chapel, Oxford, and in the west window of Magdalen College Chapel, and in a variety of modern works; and the superiority of the sunshine principle becomes apparent on comparing these works with others in which it is adopted, as the windows of the North Chapel of Brussels Cathedral, those of St. Jacques Church, Liege, or the windows of Lichfield Cathedral.

A glance at the drawings on the wall, of portions of the glass at Brussels and Lichfield will explain my meaning better than any words I can employ. We there see, that the figures are cut out from the background, and the architecture from the sky or landscape, as much by the opposition of light and shade, as by the local colours: and thus the crispness and clearness of a sunshine effect is not only highly conducive to the brilliancy of the window, but is most favourable to the concealment of the leads, which form part of and are wholly lost in the sharply defined shadows with which the foreground objects are bounded, and even in the background are on a close view not unfrequently absorbed in the colouring, but at all events pass unobserved in the general crispness of the picture, when it is viewed from the proper distance. Of course I am not speaking of the broad modern lead, used in repairs of old glass, but of the ancient leads themselves, which never until almost the beginning of the 17th century exceeded $\frac{1}{16}$-inch in width. In cinquecento glass paintings therefore, the leadwork forms an integral part of the design, equally as in a 12th or 13th century picture. And these works also evince a thorough compliance with the mosaic system in preserving the translucent qualities of glass. A cinquecento glass picture, notwithstanding the power of its shadows and high finish, which entirely save it from the charge of weakness or poverty, is still a brilliant and diaphanous glass picture; owing, partly to the crisp treatment alluded to, partly to the care taken to leave considerable portions of the glass (though not such relatively large portions as may be seen in the works of the 12th and 13th centuries) unencumbered with enamel brown. But without going further into the minutiæ of the subject, I will ask any one accustomed to compare glass paintings of different dates, whether in any so high a pictorial effect has been produced with so little diminution of brilliancy, as in the works of the second quarter of the 16th century?

You will perceive that from this summary I have omitted all notice of glass paintings of the 14th and 15th centuries. I have done so from a conviction that the nearest approach to an artistically flat style of representation is to be found in the works of the 12th and 13th centuries; and that the nearest approach to an artistically rotund style of representation is to be found in the works of the second quarter of the 16th century: and that there is nothing to choose between a really flat and a really rotund style. At first sight there is, I admit, but little difference between a 13th century and a 14th century picture, in point of composition; but a closer examination generally brings to light various minute differences, tending to show, either that the artists of the 14th century were already contemplating a change from flatness to rotundity of representation, or that they did not strictly adhere to their predecessors' rules for ensuring distinctness in a flat style. The inconsistency, not unfrequently seen in works of the 13th century, of representing the figure in relief, but omitting to indicate the recess of the niche in which the figure is supposed to stand—a mistake which perhaps arose from imitating in glass too literally the designs of ancient goldsmiths' work, where, as every body knows, embossed figures are often stuck on a flat ground, having architectural forms drawn in outline upon it—is repeated and exaggerated in pictures of the 14th century. Indeed, most of the 14th century groups that, according to the usual fashion of the day, are surmounted with shrine work, look just like groups painted on flat panels, fringed by way of ornament with spires and crockets; so completely does the apparent flatness of the canopy—rendered no doubt more conspicuous by the increased elaboration of its details—correspond with the flatness of an ordinary panel. And the figures themselves, owing partly to the increased breadth of their draperies, inattention to the principle of insulating them by means of the ground colour of the panel, and a bad selection of the colours of the drapery, certainly do not in general appear at a distance so distinct as the figures in a 13th century picture. I therefore cannot but regard the 14th century style of glass painting as inferior to the 13th, and the 15th century style as inferior to that of the 14th. The 15th century was evidently passed in the effort to get out of a flat style of representation into a rotund one. It is true that all the pictures of this period appear to be flat, but they are flat in effect only, and not on principle; their flatness is the result of imbecility, not of design. They are designed as much on the principle of depth as a cinque cento glass painting, but they do not, like it, produce the effect of depth, because their designers were ignorant of the means of attaining the desired result. As in a cinquecento glass painting, so in one of the 15th century, the figures are not unfrequently arranged on the arc of a semicircle, and are not cut out or separated from each other by stiff colour. And that the intention was to represent depth is plain from the representation of distant objects, of sky and landscape, coloured with considerable regard to the hues of nature; but, contrary to the practice of the cinque cento artists, the shadows are sometimes misplaced, and are always too weak; and the gradations of colouring, though such gradations might have been as easily made as in cinquecento work—the nature of the material being the same in both cases—are not sufficiently attended to. Hence the glass pictures of the 15th century, beautiful as they sometimes are in detail, remind one in general of an assemblage of court cards. They frequently produce no other effect, even at a moderate distance, than that of a mosaic composed of strangely-shaped pieces of glass of various colours. I think, therefore, that we may leave the works of the 14th and 15th centuries as chiefly interesting to the antiquary.

Having thus indicated, as briefly as I could, the sort of subjects which appear to be most suited for glass paintings, I will endeavour to show what sort of glass paintings are best suited for particular buildings. And here the real difficulty of the subject may be said to commence; for since no example of contemporary glazing is to be found in any building earlier than the middle ages, it is only by analogy that we can arrive at the fitness of painted glass for classical buildings, if we rely on experience as a guide; and in a matter of this sort, I fear there is no guide so trustworthy as experience. It will be admitted, I apprehend, that the earlier Gothic styles are more severe in their architectural character than the later ones; and I think that you will likewise admit, on reflection, that the glass most in harmony with Gothic buildings in the Norman or early English styles, is that of the 12th and 13th centuries. I have tried for a long time past to discover the reason of this conformity, and have arrived at the conclusion that the harmony between the painted windows and the architecture depends far more on the colouring of the windows than on their design. I have often contemplated the general effect of 13th century, of 15th century, and even of 16th century painted glass, in the windows of a Norman or early English building, from a distance too great for admitting of my making out the design with any degree of distinctness, and have invariably observed that the colouring of the earlier glass most accorded with the character of the architecture, and that the harmony was the same, whether the windows were almost entirely formed of white glass, like the Five Sisters at York, or were richly coloured, as at Bourges or Canterbury. As might have been expected, I have not met with the same opportunities of contrasting the effect of 13th century painted glass with that of the 15th or 16th century, in reference to its harmony with the architecture of the 16th century, but such experiments as I have been able to make have tended to create an impression on my mind, that the glass paintings of the 15th and 16th centuries do harmonise more completely with the character of the architecture of the 15th century than the glass paintings of the 13th. However, without pressing the last point, I will venture to express a firm belief that the colouring of a 16th century glass painting does harmonise better with the character of a building in the Renaissance style, than that of a 13th century glass painting.

In these conclusions I would beg you to observe that I have been influenced by the general effect of the glass painting, rather than by its force, because I have remarked that good cinquecento glass paintings, which are hardly if at all inferior in power to early English ones, do not in general harmonise with 13th century buildings so completely as the windows of the 13th century. The inference I draw from these experiments is, that there is an analogy between the colouring of 12th and 13th century windows, and buildings remarkable for the gravity and solemnity of their appearance. And this, when the nature of the colouring of these windows is analysed, will I think be found to accord with Sir Joshua Reynolds' views. He says in his 4th discourse, "with respect to colouring, though it may appear at first a part of painting merely mechanical, yet it still has its rules, and those grounded on that presiding principle, which regulates both the great and the little in the study of the painter. By this the first effect of the picture is produced, and as this is performed, the spectator, as he walks the gallery, will stop or pass along. To give a general air of grandeur at first view, all trifling or artful play of little lights, or an attention to a variety of tints, is to be avoided. A quietness and simplicity must reign over the whole work, to which a breadth of uniform and simple colour will very much contribute. Grandeur of effect is produced by two different ways, which seem entirely opposed to each other. One is by reducing the colours to little more than chiaro-oscuro, which was the practice of the Bolognian schools, and the other by making the colours very distinct and forcible, such as we see in those of Rome and Florence. But still the presiding principle of both those manners is simplicity. Certainly nothing can be more simple than monotony: and the distinct blue, red, and yellow colours, which we see in the draperies of the Roman and Florentine schools, though they have not that kind of harmony which is produced by a variety of broken and transparent colours, have that effect of grandeur which was intended. Perhaps these distinct colours strike the mind more forcibly, from there not being any great union between them; as martial music, which is intended to rouse the nobler passions, has its effect from the sudden and strongly marked transitions from one note to another, which that style of music requires; whilst in that which is intended to move the softer passions, the notes imperceptibly melt into one another." Now if we compare the colouring of a 13th century glass painting with that of a cinquecento one, we perceive that the colouring of the former consists of an assemblage of powerful, distinct, positive tints, skilfully arranged, but more on the simple principle of a mosaic, than on the more blended principle of a painting; whilst the tints of the latter are less forcible, less decided, and more blended together. I have seen some cinquecento glass pictures in which there is no red, and but little positive blue, the colouring being almost entirely composed of secondary tints, and in which the transition from one tint to another is scarcely more marked or sudden than is the case in some of Titian's pictures. These considerations may perhaps be sufficient of themselves to justify the opinion that the colouring of an early English glass painting is more calculated to produce a grave and solemn effect than that of a cinquecento one; but in acceding to this opinion we ought not to overlook the fact, that the tone of colour of an early English glass painting is cool, and that the tone of colour of a cinquecento glass painting is warm, and that a cool tone of colour of itself has a tendency to produce a grave effect, and a warm tone to produce a gay effect. If these views are correct, it follows that we ought not only to continue to employ for the windows of 12th and 13th century buildings, glass paintings similar to those of the 12th and 13th centuries, as regards the tone and principle of the colouring, but that we ought to glaze in a similar manner, the windows of all other buildings which can be said to possess an air of gravity and solemnity equal to that of a 12th or 13th century building: using of course, weaker colours, warmer tones, and a more elaborate mode of execution for the windows of buildings in a less severe style. Some people are of opinion that in no style but the Gothic can so solemn an effect be produced, but it seems to me that the solemn character of a building depends rather on its plans and arrangement, than on the style of its details. A Norman cathedral is as solemn as a Gothic one, and parts of the Coliseum at Rome are, I am told, as gloomy and solemn as the aisles of a Norman building. The rule therefore might well apply to certain ecclesiastical buildings in the Roman style of architecture, and I see no reason why it should not equally apply to certain ecclesiastical buildings in the Greek style: certainly these buildings, owing to the simplicity of their plan, do not possess the gloomy effect of a Gothic cathedral, but the extreme severity of the architecture imparts to them an air of gravity and solemnity, which I apprehend is rarely equalled by a 12th or 13th century building of corresponding dimensions.

I am quite aware that the employment of rich and deep colouring in windows has a tendency to diminish the apparent size of a building, and I am ready to admit that it is to a fear of producing this result, that we may attribute the modern practice of decorating the windows of a Greek building, with glass too faint in its hues to rescue it from the imputation of washiness. But it is by no means necessary to go into the opposite extreme. A glass painting entirely composed of white glass, would harmonise with the character of Greek architecture equally as one principally composed of coloured glass; provided that the white glass was, like that of the 12th and 13th centuries, solid in appearance, and had a rich cool tone. And even when the employment of a larger proportion of coloured glass might be desirable, it would always be possible to make the window recede from the eye, by using in it a predominating quantity of blue and white. But whether the advocates for powerfully coloured, or for white windows, as being most in keeping with the character of a Greek building, are right, I trust that all will agree in preferring rich tints to poor ones. Had the ancient Greeks glazed their windows, we may be certain that they would have used glass of rich tint, whether it was white or whether it was coloured. For amongst all the ancient Greek glass vessels that I have examined, I have never met with any of a poor tint, or flimsy appearance in point of colour or texture of the glass. And indeed so closely does the glass composing these remains resemble in its appearance and chemical analysis, the window glass of the 12th century (from which that of the 13th differs but little), that were I desirous of forming an idea of what Greek window glass would have been like, I should endeavour to call to recollection the tints of Suger's glass at St. Denys, or that of the glass in the west triplet of Chartres. And besides, the remains of strong colour used in the decoration of ancient Greek buildings, leads to the inference that the ancients, had they used window glass at all, would have employed that possessing a rich tint, from choice as well as necessity. We are still less without authority to guide us in regard to the design for windows proper for ecclesiastical buildings in the Greek or Roman style of architecture. The views I have expressed with reference to the colouring of these windows, must confine me to an advocacy of a simple flat system of representation, because pictures composed on the principle of representing depth, cannot properly be executed in glass entirely consisting of strong rich tints. The only attempt I have hitherto seen at designing windows for a Greek building, is at the Church of St. Vincent de Paul at Paris. But however worthy of notice these windows may be as an embodiment of a new idea, they are neither sufficiently delicate in design, nor simple in execution, to serve as models for our imitation. It is very possible that this defectiveness may be in a great measure attributable to the thinness and watery character of the glass of which they are composed, and to the efforts of the artists to disguise the badness of the material by a more elaborate execution; but such expedients are no longer necessary, since as I have before informed you, the manufacture of 12th century glass has been revived; and which I have always considered the more fortunate, on account of the use that might be made of it, in the embellishment of classical architecture, consistently with which, unlike the Gothic, art may be fully developed. There can be no doubt that valuable hints might be derived from an examination of the designs of ancient sculpture, and even of tessellated pavements. Indeed classical designs, admirably adapted for glass paintings, are engraved from sculpture in Pistolesi's Vatican, the most remarkable one is given in the 2nd vol, plate 3.[2] These designs consist of figures and ornaments in one plane, and therefore if executed in glass, as I have recommended, would a good deal resemble some of the works of the 12th and 13th centuries. These mediæval works must appear to the most careless observer to be defective in many respects, particularly in relief. When viewed closely, the intention of the artist to bring out the various projections of the figure and drapery, by means of strong black lines, is often admirable, especially as seen in the heads of the figures; but, sometimes from want of boldness, sometimes from a want of knowledge where to place the shadow, early English figures in glass, when viewed from a little distance, are too apt to appear like flat surfaces; quite as flat, if not more so, as the men and horses appear to be in those copies of the inner frieze of the Parthenon, which, placed in situations distant from the eye, and exposed to the influence of full light, are used to decorate the outsides of some of our public buildings. I am far from agreeing with those who contend that no greater relief ought to be imparted to a simple flat glass painting, than is given to those flat relievi from the cella of the Parthenon. For those who urge such views seem to have entirely overlooked the original situation of these relievi, placed where no direct light could reach them. To use the words of one of our most accomplished artists: "it is a great mistake to suppose that the flat style of relief was intended to appear flat, and it is a great mistake to apply it in situations, as in the open air, where it must appear so, and be indistinct besides."[3] In accordance with this authority, I will venture to say, that quite as much relief ought to be given to the figures in the simplest and flattest glass painting, as is given to the alti relievi in the metopes of the Parthenon, which were intended to be seen in the open air, and from a distance. I throw out these observations however, rather with reference to those who may be about to design simple flat glass paintings for mediæval buildings. For since I am perfectly sure that none but first-rate artists can design windows fit for classical buildings, I may well be content to leave the matter entirely in their hands: and can only express my surprise that a field so favourable to a display of the highest art, should have been so long neglected. Flaxman's labours sufficiently show the possibility of employing the exquisite language of the ancients to express true christian sentiment; and some of his choicest designs might advantageously be reproduced in painted windows for classical buildings, were it only by way of proving to the public, what works of art painted windows might become in competent hands.

I shall trouble you with but few remarks on the selection of glass paintings for buildings in the Palladian style of architecture, in which I would include all Wren's churches, and even St. Paul's itself; for though that building has in parts a Roman severity, its interior in particular bears many marks of the taste of the 17th century, especially in the ornamental details. Such buildings taken on the whole, are less severe in character than true Roman or Grecian buildings, and therefore would seem to require a corresponding relaxation in the character of their painted windows. In my opinion, no greater mistake is committed than when a stiff Byzantine style of decoration is applied to the windows of a Palladian building. I have heard it defended on the ground that since such glass would harmonise with the character of a Roman building, it ought equally to harmonise with the character of a Palladian one—because both styles of architecture have a common origin—in the old Roman: an argument which is at once disposed of by the remark, that the Romanesque style betrays its more immediate origin, in the Greek character of its ornaments, and some of its mouldings, from which character the Palladian is free. I have also heard it defended on the supposed necessity of imparting a more religious air to a Palladian church. But surely there must be other and more legitimate ways of increasing the solemnity of a building, than by the introduction of incongruous ornaments and decorations, which oppress the architecture by their severity. Who would think of encrusting the walls of St. Paul's Cathedral with stiff Byzantine mosaics? I believe that it is amongst the works of the cinquecento period that the true models for painted windows suitable for Palladian churches are to be sought. Amongst these works, as has been remarked, many varieties of design and character may be seen. Some are more solemn and grave than others, but the blended and comparatively undecided colouring of even the most simple, renders them less solemn and severe than the ordinary works of the 12th and 13th centuries. In most matters of detail also, cinquecento glass paintings accord with Palladian architecture. So that on the whole, the cinquecento style of glass painting, as developed in its best specimens, seems more suited than any other known style for the windows of Palladian buildings.

In adopting this style, the glass painter, as before stated, is by no means confined to the use of pictures having receding backgrounds, but may use as flat a composition as a line of well relieved figures, placed in front of a sheet of tapestry; or even in small works, or in the accessory parts of greater works, would find authority for the employment of well-relieved figures on perfectly

[2] "Il Vaticano descritto ed illustrato da Erasmo Pistolesi."—Roma, 1829; see also vol. 6, plate 81, and vol. 2, plate 4.

[3] "Contributions to the Literature of the Fine Arts," by Sir Charles Eastlake, Pres. R.A., p. 104.

flat grounds. The use of receding pictures in painted glass in any buildings of any style has, however, been strenuously objected to; and the present seems a good opportunity of inquiring a little into the validity of the objection.

It proceeds, as far as I can understand, on two grounds. The first being the supposed unfitness of the material for any sort of representation more pictorial than the mosaics of the 12th and 13th centuries. The second, the supposed impropriety of representing a receding picture on the wall of any building. In support of the first ground of objection, we are told that a glass painting reverses the conditions of nature by making the lights transparent and the shadows opaque; that the violence of its colouring is wholly opposed to pictorial effect, and that to bound objects with black lines is reprehensible on every artistic consideration. The first of these arguments is at once disposed of by the observation, that we have nothing to do with anything but the *effect* of a glass painting; and that when the material is, like that of the cinquecento period, of a horn-like texture, the high lights do *not* appear to be less solid than the shadows.

With regard to the two other objections, I admit that they would be unanswerable if it was true that an artist was precluded from painting a picture under any other than the most favourable conditions. But to assert this would be to fly in the face of all authority, and, what is worse, to contradict all experience. According to such a rule, Raphael was blameable for making designs such as the Cartoons to be worked in tapestry; "a mode of representation," says Sir Charles Eastlake, "which, in the early part of the 16th century, was far from exhibiting the comparative force of colour, and light, and shade, which it afterwards attained." He should, according to the above rule, have condescended to no means of representation less complete than what oil painting affords. Nevertheless, his availing himself of such restricted means of representation, which doubtless was imposed on him by some necessary condition, so far from being made a matter of imputation, has but increased the reputation of the artist. To use again the words of Sir Charles Eastlake, whose admirable Essay on the Styles and Methods of Painting should be carefully read by those who interest themselves in glass painting: "With a view to such faint transcripts (the tapestries) the great artist worked. He knew that his drawings would be transferred to them, and that in the tapestries alone possibly his designs might live. Distinctness was nevertheless attained without any sacrifice of such of the proper attributes of painting as were compatible with the means employed, and without any violation of probability. When we consider the great qualities which were combined with these requisites—when we find such apparently unpromising conditions had the effect of raising even Raphael above himself, we can hardly refuse to admit that a due employment of limited means of representation may at least invite attention to the most important attributes of art."[4] Unless, therefore, the conditions of glass painting are so opposed to pictorial effect as to render the attempt to produce it nugatory, I can see no possible reason for an artist declining to fill the windows of a building with pictures in which the art of representation is carried further than in the glass paintings of the 12th and 13th centuries. In many cases it might be extremely desirable that he should do so, for there are subjects very proper to be represented in places of worship which are either wholly incapable of representation in a simple flat style, or when attempted to be so represented, only prove how easily the line which separates sublimity from absurdity may be overstepped. But when pictures in painted glass, representing receding objects, actually do exist, in the contemplation of which we forget the limited means the artist had at command, and in which excellencies are discovered such as are unattainable except in a painted window, the ground of objection to which I have addressed myself appears to fail altogether.

The remaining objection, that it is wrong to represent a receding picture on the wall of a building, and consequently in a window, the glazed surface of which is but a continuance of that wall, seems to rest less on a consideration of facts or the dictates of our external senses, than on a sort of mock philosophy, which seeks to escape laborious investigation by the enunciation of a "principle"—than which, by the way, nothing is more easy. It may be conceded, that to carry a receding picture all round a room produces an ill effect; but pictures, though representing the effect of depth and distance even almost to illusion, are admitted to be allowable, provided they occupy only a portion of the wall, either by being hung against it in a frame or by being actually painted upon it; the latter sort, indeed, can plead the testimony of ages in its favour. If, then, a glass painting should have the illusion of distance, it would be unobjectionable; because, necessarily, it could occupy only part of the side of the room or building containing it. And as we are accustomed to see out of a building by looking through its windows, those who mistook the painting for a real object might easily stretch the imagination a little further, and conclude that it was some object placed outside the building, until its unreality became apparent from the figures continuing to remain motionless. But, in truth, I suspect that no one ever mistook the representation of any object in a painted window, not even a landscape, for the reality, or, except while his attention was exclusively devoted to the painting, imagined that his view extended beyond the limits of the building; a feeling which, for the moment, might be equally excited by the contemplation of a picture hung in a frame against the wall. The instant the glass painting was regarded with reference to the building it would be perceived to be nothing else than a coloured superficies, whose plane lay in the same direction with that of the wall in which it was inserted. It might, indeed, sometimes happen, that for the sake of preserving distinctness at a very great distance, a glass painting, in which figures were represented on a flat ground, would be preferable to one having a receding background. But I think that the glass painter need be deterred by no other consideration from employing a receding design if he thought proper. Indeed, a glass painting having a sky or landscape background, such as we meet with in good cinquecento examples in general, would be peculiarly suitable for a window at the end of a building, on account of the retiring nature of most of its hues. I conclude, therefore, that in the preparation of painted windows for classical edifices, the artist has the choice of a more or less severe style of representation, to be used according to the character of the building he is required to decorate; and that the type of the one style is to be found in the remains of 12th and 13th century mosaics, and that the type of the other is to be found in the glass paintings of the second quarter of the 16th century. The artist might I apprehend, be guided by similar principles in preparing painted windows for buildings in the Gothic styles.

I have already stated my belief, that the glass paintings of the 12th and 13th centuries are most in harmony with the architecture of those respective periods, and therefore think that such of those works as most consistently carry out the simple flat style of representation ought to be regarded, with but few exceptions, not indeed as objects to be reproduced in copies, but as guides to assist the artist in forming new and original designs. The principle of an ancient composition might be more strictly adhered to now than at any former period, on account of the revived manufacture of the window glass of the 12th century; but this recommendation would by no means involve the necessity of copying the object itself. Indeed, nothing is more thoroughly opposed to sound sense and good taste than a mere servile copy of an ancient glass painting, or a copy with such trifling modifications as to be little else than a servile copy. If intended as a counterfeit, it must fail in its object—for none but the inexperienced are likely to be deceived by it; and once known to be a counterfeit, it would lose all interest from association with bygone ages. If intended to pass for nothing more than a copy, under the *bonâ fide* impression that nothing except a copy of ancient painted glass will harmonise with Gothic architecture, it serves but as a cover for indolence; it can advance nothing, because a copy is sure to fall short of the original in all real merit; and besides this, its production amounts to an unconscious satire on Gothic architecture, when we consider the imperfect state of the art of representation as displayed in ancient windows. The only true course is to treat every modern work in painted glass as an original work of the 19th century; and as such, to test it according to intelligible rules of taste. The inquiry ought no longer to be confined to the narrow issue of conformity with some ancient authority, but should extend to a consideration of its intrinsic merit as a work of art, and its extrinsic merit as being in harmony with the architecture with which it is associated. To prescribe so wide a field of inquiry might, indeed, prove inconvenient to certain critics, but would certainly tend to a more zealous investigation of the principles of ancient art than heretofore, and to the production of works more worthy of the 19th century: in short, it is by this means only that any progress can be made.

4 'Contributions to the Literature of the Fine Arts,' by Sir Charles Eastlake, p. 133.

A 19th century window, designed for a 12th or 13th century building, ought not only to harmonise with the architecture in the quality and treatment of its colouring, but, besides restraining conventionality within due bounds should likewise be free not merely from the bad drawing, but from the quaint and contorted attitudes of the figures of the 12th and 13th centuries; attitudes which, however fashionable they might have been at that period, are shocking to our present tastes and feelings. It should, in fact, reproduce nothing but the art of that period, the genuineness of which will only appear the plainer when the film of bad taste and deformity is stripped from it, through which we are now obliged to penetrate before we can fairly see it. I should add, that in designing a window for a 12th century building, the artist can never do wrong in going at once to the fountain-head, and correcting his taste by the remains of classical art, whose influence is so easily recognised in the glass paintings of the 12th and 13th centuries.

A consideration of the colouring best suited for the windows of a 14th century building presents an interesting subject of inquiry, but into which I cannot, for want of time, particularly enter. The glazing of the 14th century, until about the year 1380, in respect of the quality and disposition of its colouring, holds in general a sort of middle place between the rich mosaics of the 13th century and the paler picture-glass paintings of the 15th century. Its individual colours being as cool and almost, if not quite, as powerful as those of the 13th century—but being intermixed with a much larger proportion of white glass, and used in broader masses. But this difference in the character of the colouring seems attributable rather to the nature of the designs which became fashionable in the 14th century, than to any definite abstract principle. But however this may be, there is one lesson to be learnt from the works of the 14th century, if not from those of the latter part of the 13th, which is, that the glazing which chiefly consists of white glass is more favourable to the effect of window tracery than that which consists of a mass of intensely rich colours. For the latter tends to confuse the tracery, unless, indeed, the direction of the principal lines of the glass composition are strongly opposed to the lines of the stonework, in which case there is a sufficient contrast between the stone tracery and the deep coloured glass to render the former perfectly distinct. Thus the mullions and tracery come out strongly in some of the clerestory windows at Bourges, and in the windows of York Chapter House, where the glazing is principally white, but are not so easily made out in the windows of the Sainte Chapelle at Paris, which are filled with richly-coloured glass. On the other hand, the mullions of the southern rose at Chartres, which is likewise filled with richly-coloured mosaics, show themselves distinctly, as appears from the diagram I now exhibit. Here the principal lines of the stonework diverge, like rays, from the centre of the window, whilst the principal lines of the glass composition form concentric circles. The star-like effect of this and many other rose windows of the 13th century (the north rose of Notre Dame at Paris is another example) thus being produced by the opposition of two distinct designs; one of which, the stone design, appears as if it was laid upon the other. If this consideration should lead to the conclusion that glazing, principally consisting of white glass, is best suited for the windows of buildings in the Decorated style of architecture, there can be little doubt, I apprehend, that the best designs would be those consisting of pattern work painted on white glass, of which there are numerous and beautiful examples in the Cathedrals of York and Exeter, Merton Chapel, Oxford, and other places, with or without the enrichment of inserted panels containing groups or single figures on stiff coloured grounds, executed in the simple flat style before mentioned. I would on no account advocate the use of figures and canopies, because the stiff character of the colouring, which does not materially differ from that of the 13th century, is unfavourable to such a display of light and shade as is necessary to make the canopies seem as if they projected forward. I have heard the flatness of decorated figures and canopies defended on the score of their resemblance to some of the published outlines of the German engraver Retsch; but these outlines are only intended for near inspection, by which alone the varying thickness of the outline, which produces the effect of light and shade, can be appreciated. At a distance, these designs would of course be invisible; or if enlarged in painted glass, as I have also heard recommended, would appear flat and thin—just as would a copy of a 14th century monumental brass, if executed in painted glass.

The change in the nature of the material in 1380, or thereabouts, and the substitution of glass, such as we see used in the works of the 15th and 16th centuries, for the deep intense tints previously employed, is like many other points connected with the history of an art, one on which no light has hitherto been thrown. It is but a conjecture that the change was brought about by the glass-makers in Germany. But I think we may conclude, from the fact that glass painting was becoming more pictorial just before the change in the material, and that it became still more pictorial after it, that the lowering of the different tints in depth was intended to second the efforts of the artist to produce glass pictures in preference to glass mosaics. One is tempted to infer the existence of some harmony between the character of the architecture and the delicate tints and silvery tone of the glass of the 15th century, from their having been so long associated together. And in one respect, the glass is no doubt well suited to the architecture. For even the most elaborately painted window is, owing to the lightness of its hues, never confused with the stonework. And experience has abundantly shown that the effective pictures of the 16th century harmonise as well with the architecture of the 15th as the imperfect productions of that period. There is no apparent difference between the architecture of the windows of Fairford Church, Gloucestershire, and that of the windows of churches quite half a century earlier; and yet the 16th century glass, with which these windows are filled, is in perfect harmony with the character of the building. I therefore think that windows for 15th century buildings should be designed on the model of the glass paintings of the 16th century; in which case the artist might consistently employ canopies if he thought proper. The most splendid Gothic canopies in glass that I have ever seen are in two of the windows of Munich Cathedral; one is dated 1503. These canopies are so painted as to appear like what they profess to be—hollow niches. As a general rule, it appears more satisfactory that one scale of figures should be preserved throughout a window, than that the size of the figures should be regulated by the sizes of the lights they occupy, as in most Gothic examples. In the cinquecento period the uniformity of scale was preserved not unfrequently by the employment of angel boys instead of full-grown figures, to fill the smaller tracery lights. At Fairford and other places the expedient adopted is the use of demi-figures in the tracery lights.

In the 15th as well as in the 16th century it was a not uncommon practice to extend the design of a glass painting beyond the limits of a single light. In some instances, the entire window is filled with a single picture, which is spread over the whole opening, independently of the mullions. So great an outcry has, however, been raised against this practice that it seems worth while to say a few words in justification of it. In the first place, there is not, I conceive, a greater violation of principle committed in laying, as it were, the design of perpendicular tracery work over the design of a 15th century picture in glass than is committed in laying the design of a 13th century rose window over the design of its glazing. The stonework of the window sustains no injury of effect; on the contrary, it is rendered more distinct by the opposition of its design to that of the glass. Neither is the glass painting injured by being cut by the stonework, for, as remarked by a member of this society on a former occasion, the force of imagination is such, that the design may be preserved in all its unity through any number of lights; an observation which, I think, will be admitted to be true by those who have been in the habit of looking at such works with an unbiassed eye. But the practice may be defended on another and perhaps less questionable ground—on the score of necessity. Our ancestors were in the habit of representing in their windows vast numbers of legendary saints; but modern practice is in general so opposed to this as in effect to limit the choice of the artist to representations of our Saviour, the four Evangelists, the twelve Apostles, occasionally the Virgin Mary, and some of the Prophets and Patriarchs. I believe that I am speaking within compass when I say that his choice does not extend beyond three dozen single figures. Consequently monotony is inevitable, unless recourse is had to groups of figures. Here, indeed, the means of selection is almost unlimited. Flaxman declares (Works, p. 337), that it may be affirmed, "without danger of exaggeration, that many hundred subjects are to be found in the sacred writings, which, being ably designed, would be *new* to the beholder." But in order to insure a sufficient scale for the figures, the group must not unfrequently be extended beyond the limits of a single light. Upon the ground, of necessity, therefore, we may well justify the carrying a glass picture across a window, to a certain extent, irrespective of the mullions. And I should perhaps add, that when we consider that painted windows by their size might not unfrequently offer a field for the talents of the historic painter, it seems unadvisable to scare artists from it by imposing conditions, which were often broken through by the mediæval painters themselves.

In conclusion, I will repeat what I stated at the outset, that I claim no infallibility for any of the views I have advanced. I am conscious of having approached delicate ground more than once; especially in the course of my remarks on the sort of glass paintings best suited for buildings in the classical styles. On this point I consider that I have but raised questions which wiser heads than mine must solve. My object will have been accomplished if I have added but one grain of information to the common stock; or if have succeeded in proving that there is no mystery in glass painting—that it is a branch of the fine arts, distinguished from others only by certain conditions, and that the same sober rules of criticism equally apply to the productions of the glass painter. To take a familiar instance, we sometimes hear it disputed whether the flesh ought to be coloured or left white in a glass painting; the opponents of tinted flesh urging the impossibility of imitating nature exactly in this respect. The answer is obvious enough. The whole colouring of a glass painting is highly conventional, whether it be of the draperies, of the flesh, of the sky, or of any other object; still, so long as it does not exceed the limits of conventionality—a point to be ascertained only by observation and general opinion—the eye and imagination are satisfied. We should be startled and disgusted at seeing flesh painted green or blue, but the complacency with which pink or white flesh in a glass painting is regarded by the generality of mankind is a sufficient proof that neither of those tints contradicts nature too violently; and therefore that the artist does not exceed the limits of conventionality in using either white or tinted flesh at his discretion. The wide range of this paper, and the necessity of confining its length within reasonable limits, has of course compelled me to touch on several topics in a very cursory manner, and especially that relating to the actual mode of executing a glass painting, on which the argument in favour of the mosaic system almost entirely depends. However, as I went into this subject at great length in a little work I published in 1847,[5] and of which there is a copy in your library, I must refer those to it who are inclined to pursue the matter further. It may seem superfluous to those who have read this book to assure you that there is a perfect consistency between it and such views as I have just expressed; but as certain writers are in the habit of taunting me with inconsistency, I may as well state that the only foundation for the charge is this: that perceiving at the time when that book was written that modern copies of the 13th century windows, besides being very raw in colour, were, owing to the extreme pellucidness of the glass then in use, thin and poor in effect; the most favourable examples never having a more imposing air than a *veneer* of an old window might be expected to have, and that the process of antiquating the glass—that is, dulling it over with enamel brown in imitation of the effect of age, only produced dulness without imparting depth, I ventured to suggest the adoption of shadows, such as we see in cinquecento work, as well as a broader style of colouring than was used in the mosaics of the 13th century, as a means of correcting the flimsiness without destroying the brilliancy of the material, and, at all events, of giving *power* to the work. And that since the manufacture of the 12th century glass has been revived, I have advocated a nearer approach to ancient precedents, both in the execution of the painting and the method of its colouring. I trust this brief explanation will finally dispose of the charge to which I have alluded; a charge which never would have been made, any more than the absurd misrepresentation that I have at any time recommended the universal employment of the cinquecento style, details and all, had it not been for those writers' ignorance of the subject on which they professed to write, and their consequent inability to comprehend any argument in relation to it which is founded on general views. To you, gentlemen, I am indebted for the patience with which you have listened to so long and dry a discourse.

[5] 'An Inquiry into the Difference of Style observable in Ancient Glass Paintings,' by an Amateur, p. 236, *et seq.*

## MANCHESTER CORPORATION WATERWORKS.

Mr. J. F. Bateman has presented the following report, dated October 5, 1853, to the Waterworks Committee of the Council of the city of Manchester:—

The works are steadily advancing towards completion. The operations alluded to in my last report for preventing the leakage at the Woodhead Reservoir, which existed on the Derbyshire side, have been attended with great advantage. The leakage is only one-fifth of what it was when we commenced, and is now inconsiderable, notwitstanding that the water in the reservoir is kept several feet higher, and the pressure thereby increased. The water is maintained at a depth of about 50 feet, being about 30 feet below the waste weir.

The embankment of the Torside Reservoir is within about 18 inches of its full height, and all the work in connection with the reservoir may probably be completed by the end of the year.

At Rhodes Wood Reservoir the embankment has been stationary for some time, but the works for arresting the motion of the land-slip, and for rendering the reservoir watertight over the moved ground, are proceeding rapidly and satisfactorily.

At the Hollingworth and Arnfield Reservoirs the works are rapidly drawing to completion. The tendency to slip, which has occasioned a good deal of trouble in these embankments, has now, I hope, all but ceased. The water in the Arnfield Reservoir has for some time been within seven or eight feet of its full height.

Some repairs have been found necessary both on the Rhodes Wood Conduit and at Crowdon Weir, for the purpose of remedying leakages which occurred at both works after they had been supposed to have been satisfactorily completed.

## PAVING AND SEWERING OF STREETS.

Mr. John Francis, surveyor, has made the following report to the Paving, Sewering, and Highways Committee of the Council of the city of Manchester. He states that the seventh year's experience in tubular sewerage has served further to strengthen his conviction of the complete adaptation of glazed fire-brick tubes to the purposes of town drainage, under judicious regulations. The Manchester system of sending through the tubes not only house sewage, but the general surface drainage of the town, up to the measure of their capacity, is preferable to, and has met with a success unknown to the "separate system," because the tubes are flushed in every shower and storm, and deposit is thereby prevented or removed.

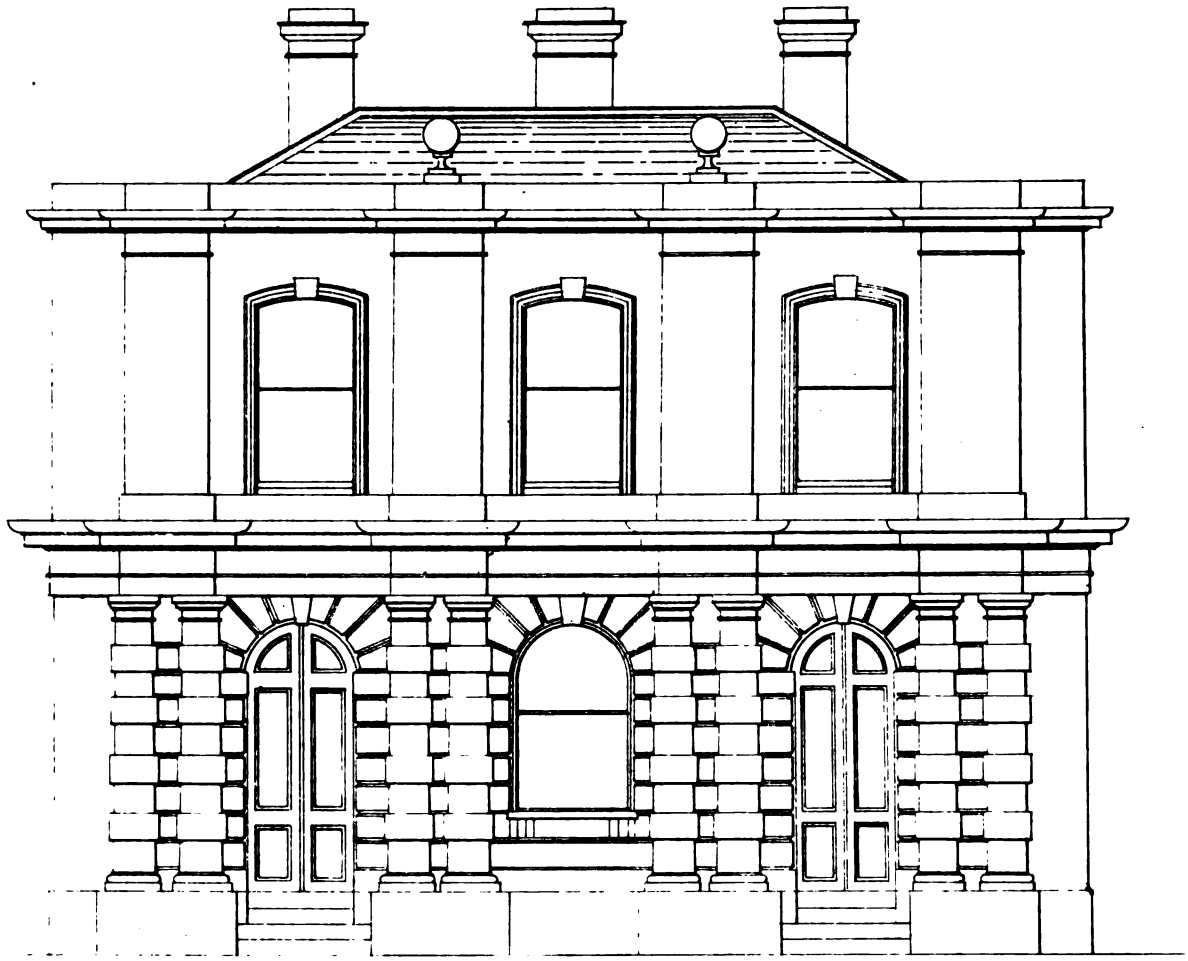
Table *showing the Cost of Paving and Sewering the Streets of Manchester, the years* 1843 *and* 1846 *being given to afford the means of Comparison with the Expenses of Subsequent Years.*

| Date. | Total Area. Square Yards. | Total Cost £ | s. | d. |
|---|---|---|---|---|
| From Oct. 1842 to Oct. 1843 | 32,572·4 | 12,684 | 1 | 9 |
| ,, 1845 to ,, 1846 | 58,890·7 | 20,799 | 5 | 3 |
| ,, 1848 to ,, 1849 | 22,915·7 | 7,807 | 9 | 7 |
| ,, 1849 to ,, 1850 | 56,844·0 | 17,687 | 7 | 3 |
| ,, 1850 to ,, 1851 | 27,097·8 | 7,311 | 18 | 9 |
| ,, 1851 to June 1852 | 20,826·5 | 5,120 | 6 | 4 |
| From June 1852 to ,, 1853 | 31,363·6 | 7,994 | 8 | 3 |

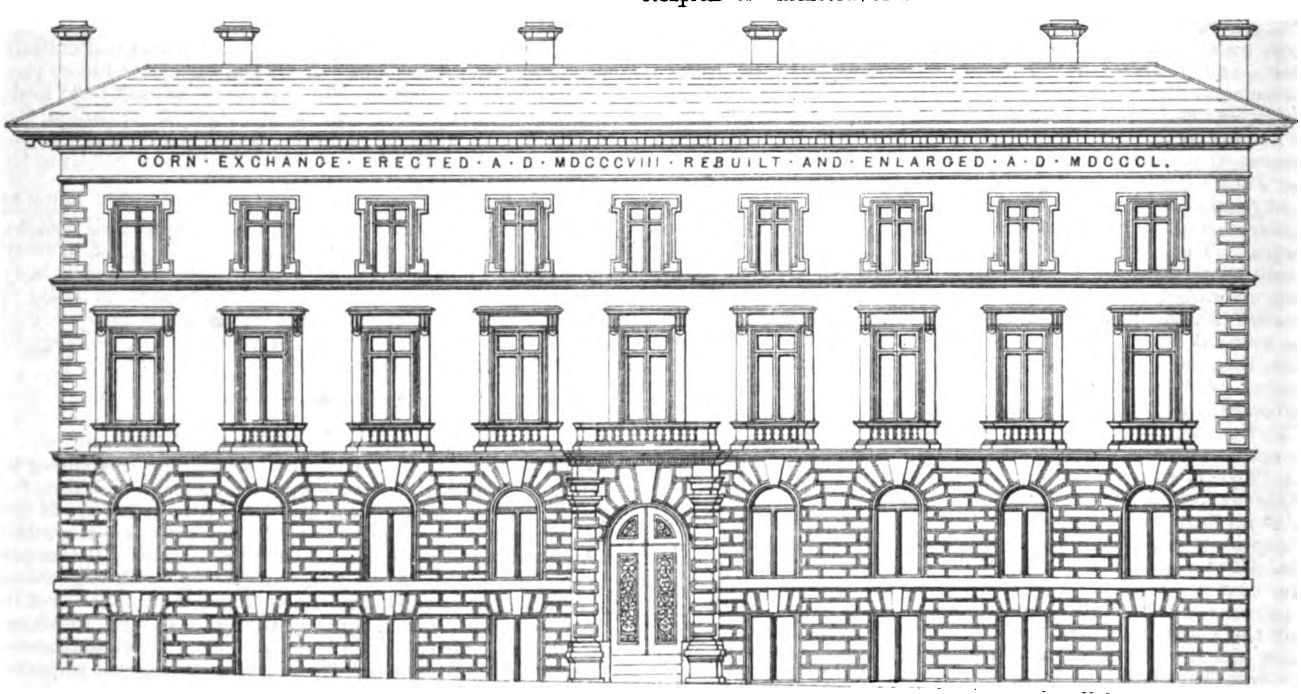
Various specimens of stone have been submitted for the inspection of the committee; but these, for the most part, have not been of a character sufficiently durable adequately to resist the heavy weights and continuous traffic to which the leading thoroughfares of the city are subjected; and in the few specimens where, from the appearance presented and the tests applied, durability might be presumed, the tendency to slipperiness has constituted an objection to their adoption.

The experience of the committee, so far as it enables them to determine, inclines them to think most favourably of the granite sets from Nevin, which, with almost equal durability, combine far less tendency to slipperiness than Welsh blue sets.

*Whitney's Inkstand.*—This invention consists of an ordinary glass inkstand, made entire, with the exception of two openings in its upper surface. One of these is covered with an elastic diaphragm, regulated by a screw; into the other fits air-tight a small glass funnel, the neck of which reaches nearly to the bottom. By compressing the air above the level of the ink by means of the screw, the ink rises up into the cone of the funnel. The whole fits into a neat frame supporting a rack for pens, &c.



T Y N E M O U T H   B A T H S.
Ashpitel & Whichcord, Archts




C O R N   E X C H A N G E ,   L I V E R P O O L .
I. A. Picton, F. S. A. Architect

J.R. Jobbins

## LIVERPOOL CORN EXCHANGE.

(*With an Engraving, Plate* IV.)

THE original corn market in Liverpool, like most other towns, was held in the open street, in front of the Exchange. In the year 1807, a scheme was set on foot for the erection of a covered market by the issue of 100*l.* shares. A building was accordingly constructed on the south side of Brunswick-street, which was opened for business in August 1808. The plan succeeded admirably as a pecuniary speculation, the original 100*l.* shares having advanced to the value of 350*l.* and 400*l.*

The increase of business, especially in the import of foreign grain, having led to the inconvenient crowding of the market, a new erection was determined on. The old structure was taken down, and premises adjacent purchased sufficient to enlarge the Exchange to nearly double its original extent. The present building was commenced in 1851, but owing to the difficulty of getting possession of part of the property, it had to be erected piecemeal. The façade was commenced in the spring of the past year, and is rapidly approaching to completion.

The ground plan is a little irregular, owing to the nature of the site. The situation being in the centre of the commerce of Liverpool, the front portion of the building is prepared for offices or commercial chambers, of which there are eight suites. The area of the Exchange itself is about 100 feet by 98 feet, which is divided into three aisles by two rows of iron columns. The centre avenue has a raised clerestory carried up, lighted from the sides. The two side avenues are lighted by continuous rows of plate-glass squares, forming the upper portions of the planes of the roofs. The roof itself is supported by cast-iron curved ribs, segmental in the side avenues and semicircular in the centre one. Two ranges of vaults for storage extend under the Exchange.

The number of stands for the accommodation of the dealers is 170, each of which is let for 15*l.* 15*s.* per annum.

The front façade is built with white Runcorn stone, which is of beautiful colour and excellent quality, but very limited in supply. The total cost of the building, exclusive of the land, will be about 11,000*l.* The architect is Mr. J. A. Picton, F.S.A.

## THE "PHŒNIX" IRON WORKS, RHENISH PRUSSIA.

IN 1844, a company was established at Eschweiler-aue, near Aix-la-Chapelle, under the arrangement called by the French "Société en commandite," for the purpose of working iron on a large scale, manufacturing rails, hoops for wheels, stakes, iron plates, and steam boilers. This establishment bears a high character, not only in the Zolverein, but also in the neighbouring states, and employs 2000 workmen. The company with a capital of about four million francs (160,000*l.*) have realised such large returns, that the balance sheet which was drawn up on the 30th of last June showed a yearly profit of *one million four hundred thousand francs* (56,000*l.*) This has been made in a manufacture, the cast-iron employed in which came from Belgium subject to heavy duties. The carriage of Belgian cast-iron from the nearest localities to Eschweiler costs six francs (4*s.* 9*d.*) per ton. The duty amounts to 18f. 75c. (14*s.* 10½*d.*), and in the event of existing treaties (which expire on the 1st of January) not being renewed, the customs dues will amount to twenty-five francs (1*l.*) Moreover, the cost of transporting the manufactured article from the present establishments to the Rhine, where it is almost invariably delivered, amounts to six francs (4*s.* 9*d.*) per ton.

To free itself from those enormous expenses the society decided on making its own cast-iron and starting a joint stock company, the Phœnix, with a capital of three million of thalers, divided into 15,000 shares of 200 thalers or 750 francs (30*l.*) each. The object to be attained was the production of a sufficient quantity of iron to supply the numerous orders which the development of industrial activity and great railway undertakings multiply every day. The customs returns for the year 1851 (at that period neither Hanover nor Oldenburg formed part of the Prussian Zolverein, and the commercial treaty concluded with Austria for twelve years had not yet been signed), yet showed that 127,000 tons of cast-iron were imported from England and Belgium, but principally from the latter country. The importation will rise to a much higher figure, for in 1851 the consumption in the Zolverein only represented in proportion to the population the third part of that of France.

There could be no hesitation as to the site of the present establishment. It was on the right bank of the Rhine on the Ruhr,—for there ore and coal were to be found in abundance, and of excellent quality. One of the new establishments is being erected at Ruhrort, on the Rhine, in the vicinity of three large coal mines which the Phœnix Company have taken for thirty years, on a plot of ground admirably situated at the mouth of the Ruhr, between the Rhine and the railroad from Cologne to Minden.

Other foundries are in progress of erection at Kupferdreh, on the Ruhr, not far from the Rhine, in immediate communication with the Steele-Vohwinkler railroad, and in the midst of ferruginous and coal beds formations. Twelve foundries are being constructed, and the first which are finished will be worked before the end of the present year 1853.

The annual production is temporarily fixed at 90,000 tons of cast-iron and 70,000 tons of wrought-iron. These quantities can easily be doubled in case of necessity. As to the advantage likely to accrue to the company (the Phœnix,) from these establishments, they are easy to appreciate—in fact, the outlay for coal, ore, and labour, as well as the preliminary expenses, will be much less than those of the Belgian manufacturer, and they will no longer have to support the heavy expenses of carriage from Belgium, &c.

These advantages constitute a clear gain of not less than 40 francs (1*l.* 11*s.* 8*d.*) per ton, or three million six hundred thousand francs (144,000*l.*). They will economise 371,250 francs (14,850*l.*) in the expense of transport, and the profit in manufacture of iron (and double profit with triple production is below the mark,) will be 2,700,000 francs or 108,000*l.*

There is the less exaggeration in the above result from the fact of the numerous orders which the company are at present executing, and must successively execute, presenting much more advantageous prices than those which produced the profit of one million four hundred thousand francs, cited above.

F. P. H.

## TYNEMOUTH BATHS AND WASH-HOUSES.

(*With an Engraving, Plate* IV.)

Messrs. ASHPITEL and WHICHCORD, *Architects & Engineers.*

IN our last Number we presented to our readers a plan of this useful establishment. We now give the elevation facing the principal street, which is the only part of the building of two stories in height; the other portion contains the baths and the washing compartments, which are lighted and ventilated from the roof.

The façade is simple and appropriate, and is executed entirely in Yorkshire stone, the column shafts and some of the more prominent lines being polished. The entrance on the left hand leads to the men's baths, while that on the right is for ladies, the centre window lighting the pay-office, which serves as a division between the sexes. The upper story is allotted as a residence for the superintendent of the establishment.

We have much pleasure in directing attention to a building for this valuable purpose, executed on a *moderate scale*, as it shows that there is no reason why they should not be added to every town in the kingdom. It is one matter to charge a public body with the erection and maintenance of a structure at an outlay of 6000*l.* or 7000*l.*; but when, as in this instance, the institution is produced at one-third of that sum, it comes within the range of towns of the most modest pretension.

## KIDDER'S GAS REGULATOR.

MR. KIDDER, of the United States, has designed a regulator to be attached between the service-pipe and meter in buildings, for the purpose of preventing the fluctuations in the light, due to the unavoidable variations of pressure in the street mains. It consists of a small telescopic gas-holder, sealed with mercury. The upper section carries a rod, to the lower portion of which is a conical valve, apex upwards, which fits into a corresponding socket in the lower opening, or that for the entrance of the gas, which, as it rises with the upper section of the gas-holder under an increase of pressure, controls the supply, and consequently the pressure. The apparatus resembles the governor used at the gas-works to control the supply of gas from the gas-holders to the street-mains; the latter, however, is sealed with water.

## RESISTANCE OF THE VERTICAL PLATES OF TUBULAR BRIDGES.

By H. Haupt, C.E.

The great desideratum in the construction of bridges is an arrangement of parts that, with a given weight of material, will possess the most efficient powers of resistance. An arch fulfils the condition of maximum resistance with a given weight of material when the distribution of the load is constant. With a permanent weight, whether uniformly distributed or not, there is a curve of equilibrium; and a given amount or weight of material arranged to conform to this curve, will give the maximum of resistance which the material is capable of opposing. But for ordinary bridges, especially for railroad purposes, there can be no curve of equilibrium; the load is not only variable, but very great in proportion to the weight of the structure, and were an equilibrium possible in one position, it could remain stable only for an instant, as the transit of the load to another position would at once disturb it.

It is evident, therefore, that the principle of equilibration is applicable only to aqueducts, or other structures upon which the loads are nearly constant, and that to render an arch capable of sustaining a variable load, it must either be made so deep that the variations of the curve of pressure will never pass outside the arch, or it must be combined with a resisting truss capable of effectually opposing any tendency to change of figure. Most of the bridges in general use are illustrations of this species of combination; but the main reliance is usually placed upon the truss, the arch being used merely as an auxiliary. When wood is used, this increase of material is not objectionable, except so far as it increases unnecessarily the weight of the structure; but where iron is employed, it becomes essentially important that the distribution of the forces should be understood, the strains upon all parts of the structure accurately determined, and the dimensions correctly proportioned to the required resistances.

The principles involved in these calculations have already been given to the public, in a work on the 'General Theory of Bridge Construction,' and no further reference to them is required, except to state that an application of these principles would lead to a radical change in the manner of constructing bridge trusses; and, instead of using an arch as an auxiliary to a truss, the arch would be made the chief dependence, and the truss employed to resist the action of variable loads, and prevent change of figure in the arch during their passage over the bridge. When disposed in this manner, a given quantity of material will oppose an efficient resistance either to vibration, flexure, or fracture.

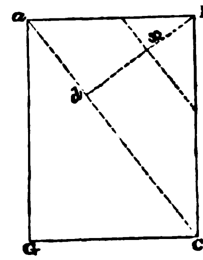
In tubular iron bridges, which have recently attracted much attention, no difficulty is found in determining the strains upon the horizontal tables, and in proportioning them correctly; but the dimensions of the vertical ribs, and the best manner of stiffening them, will depend not only upon the magnitude of the weight, but upon its mode of application. If the weight be supposed applied at the middle of a tubular bridge, its action would tend to shorten the diagonal extending from the middle of the top chord or table to the end of the bottom table, and at the same time to elongate the opposite diagonal from the middle of the bottom table to the end of the top table. As the strain upon the last diagonal would be tensile, its ability to resist would be nearly as the strength of the material; but the opposite diagonal, being subjected to compressive forces, would, if it formed a line of a thin plate of metal, be unable to oppose any efficient resistance, and the bridge would probably fail in the direction of this diagonal. It becomes necessary, therefore, to provide means for stiffening the ribs, and this is usually effected by riveting to them, vertically, pieces of T-iron at short intervals.

By these additions, the distribution of the strains is changed, and the action of the parts is similar to that of a truss on the Pratt plan—the vertical stiffness taking the place of the posts, and the lines of sheet iron connecting the opposite angle of any panels having a corresponding action to the ordinary diagonal rods. The resistance which such an arrangement is capable of opposing, it is proposed to determine from the following considerations.

In the general theory of bridge construction, it has been demonstrated, that where the load is uniformly distributed the vertical strain increases uniformly from the middle to the ends; the strain upon the diagonal of any panel will be as the length of the diagonal to the length of the vertical side, and also as its distance from the middle of the truss; the maximum vertical strain being of course equal to the whole weight of the bridge and its load, with the momentum due to motion and vibration, when the structure is not rigid.

It has also been shown, that the vertical and diagonal strains upon any panel which are always proportioned to each other in a fixed ratio, are also in proportion to the degree of annular motion or change of figure in any panel caused by flexure; and as the settlement of a bridge to the figure of an inverted arc would not change the rectangular shape of the middle panel, the vertical and diagonal strains upon this panel would be theoretically nothing; while, at the end of the truss, the variation from a rectangle, and the intensity of the vertical and diagonal strains would be greatest.

Knowing the whole weight of the structure, the strain upon any panel is readily determined, and it is now proposed to inquire what will be the resistance of a sheet of metal securely attached to all the sides of a rectangle, in comparison with an equal quantity of material arranged in the form of diagonal rods. It is evident that the consideration of this question will afford the means of comparing the relative efficiency of the distribution of the material in tubular bridges, as compared with diagonal panel rods.




Let $a$, $c$, in the annexed figure, represent the diagonal which is subjected to a tensile strain, and R, the resistance per unit of area which the material is capable of opposing; ($a$), its perpendicular distance B, $d$, from the fulcrum B. The strain upon a unit at the distance $x$, will be in proportion to this distance, and will be represented by $\frac{R}{a}x$. But as the efficiency of the resistance will be in proportion to the leverage, which is $x$, the whole effect of a unit of material at the distance $x$, will be expressed by $\frac{R}{a}x^2$, and the sum of the resistances along the line $d$ B, obtained by the usual method of integration, will be $\frac{1}{3}Ra^2$, or $\frac{1}{3}Ra + a$. As R, represents the resistance of the material per unit of area, and ($a$), the number of units in the distance B $d$, R $a$ would represent the resistance of a rod whose area is $a$, and $Ra + a$, its moment of resistance at the distance B $d$. As the resistance of the triangle $a$ G C, is necessarily equal to that of $a$ B C, the whole resistance of the rectangle $a\,b\,c\,g$, will be $\frac{2}{3}Ra^2$. The resistance expressed by $\frac{2}{3}Ra^2$, is obtained by the use of an area of material represented by $a\,c$ + B $d$. If this same amount of material should be placed in the form of a rod in the diagonal $a\,c$, its cross section must be equal to B $d$, or $a$, and its effective moment would be $Ra^2$.

It appears, therefore, that the power of a plate to resist an angular change of figure in a rectangular frame will be two-thirds as great as that of an equal quantity of material placed in the direction of the diagonal. Where a truss is designed to support a constant weight uniformly distributed, or, in other words, where counterbracing is unnecessary, the adoption of the tubular or plate arrangement involves an expenditure of 50 per cent. more material than would be required by diagonal rods; but where the load is variable, as is always the case in bridges, and where rods are consequently required in both diagonals, the relative economy of the two arrangements is more nearly equal, and may even be reversed. In a truss which is unsupported by an arch, a calculation of the quantities of material required in the two arrangements involves a consideration of the strains produced by the variable and constant loads in each panel. In the middle panels, the strain from the weight of the structure being theoretically nothing, the diagonals resist only the effects of the variable load, and must be equal. If the area of each rod be represented by $\frac{2}{3}a$, the two would be $\frac{4}{3}a$; but as the braces and counterbraces are never both in action at the same time, the plate arrangement requiring a quantity of material represented by ($a$), would be equivalent to the braces and counterbraces both, and would effect a saving of material equal to $\frac{1}{3}a$. The rods in this case would require 33 per cent. more material than the plate.

If $\frac{2}{3}b$ represent the material required in the rods of the end

* Read at the Meeting of the American Association for the Advancement of Science, July 1853.—Reported in the 'Journal of the Franklin Institute.'

panels to resist the weight of the structure, then $\frac{2}{3}b + \frac{2}{3}a$, would be required for the main diagonal rods, and $\frac{2}{3}a$ for the counter-brace, making $\frac{2}{3}b + \frac{4}{3}a$. The plate arrangement would require $b + a$. The difference is, $\frac{b-a}{3}$. Hence, if $a$ should be equal to $b$, the value of the expression becomes zero, or, in other words, if the variable and constant loads are equal at the end panels, the quantity of material in the rods and plates will be the same; but if the variable load is least, there will be a loss of material by the use of the plates which will be greater as the weight of the structure increases, and, consequently, the relative economy of plates would be less for very long spans than for shorter ones.

These considerations naturally lead to the substitution of sheet iron for the rods of wooden bridges, and its adoption will secure the essentially-important advantages of simplicity, economy, incombustibility, and durability, if practical difficulties do not arise from the expansion and contraction of the plates when attached to wooden frames. As the expansion of diagonal rods is not found to be productive of any injury or inconvenience, it is possible that the slight bending or buckling which must result from the expansion of the iron plates might not lead to any serious consequences; but whether the plan of constructing bridges by covering wooden frames with sheet iron be practicable or not, the result of the calculation that has been given proves, that with a sufficient number of posts or stiffeners, the vertical plates in tubular iron bridges may be very thin, and still possess sufficient powers of resistance—a conclusion, the truth of which is confirmed by the experiments on the Britannia Bridge.

A tubular iron bridge without arches, to be properly proportioned, should have the number or thickness of the top and bottom plates increased, and of the side of vertical plates decreased gradually from the ends to the middle. A tubular bridge, in which the plates are of the same dimensions in the middle and at the ends, must be very badly proportioned, and contain a large amount of useless material.

If $v$ represent the variable load upon a single panel or interval between two adjacent posts or stiffeners, $n$ = number of panels, $w$ the whole weight of the structure, then the proportion between the thickness of the vertical plates in the middle and at the ends, will be nearly as $\sqrt{\frac{n\,v + w}{2}}$; as this proportion may readily be as great as 1 : 5, it follows that a very great saving may be effected by proportioning the thickness of the sheets in each panel to the strains, an arrangement that appears to have been overlooked or neglected in the construction of tubular bridges.

## CONVERTING RECIPROCATING INTO ROTARY MOTION.

NATHAN ATHERTON, *Inventor.*

This invention consists in applying a cylinder with a right and left continuous groove (forming a double inclined plane or screw), the pitch and diameter of which is in proportion to the length of the stroke of the piston.

If for a steam-engine, for example, then, according to the length of the stroke of the reciprocating motion to which it shall be applied, the inventor constructs his cylinder, called the impulse cylinder, by having cast or cut in its surface a groove, starting at a point near one end of the cylinder, and continuing around the cylinder to a point on the opposite side from the starting point, and near the other end of the cylinder from the starting point; and from this second point he continues the groove around the cylinder, returning to the starting point; thus making a continuous groove, and forming a double inclined plane.

This cylinder is applied properly housed, so that it may revolve on its shaft. A friction-wheel is attached to the crosshead, and works in the groove of the impulse cylinder. The crosshead, upon being propelled forward, causes the cylinder to make a half-revolution, and upon the crosshead being returned down the groove of the other side of the cylinder to its first position, will complete the full revolution of the cylinder upon the shaft.

## ECHOL'S WATER GAUGE FOR STEAM BOILERS.

THIS invention, at present under consideration by the Committee of the Franklin Institute, consists of a metal cylinder, of about $2\frac{1}{2}$ inches diameter attached to the boiler by two smaller tubes, provided with stop-cocks, one entering above and the other below the water-line. Midway of the vertical height of the cylinder are two openings opposite each other, in which are screwed hollow nuts, the inner openings in which nuts are closed by hemispheres of glass, the convex portion inwards; between these rises and falls a graduated rod attached to a float, the numbers on the rod being visible as they come opposite the openings.

The stop-cock at the lower end of the gauge is a three-way cock, and may be thus made to cut off communication with the water in the boiler, and open a small vent-tube leading externally, by which means all the water in the gauge may be blown out in case of any obstruction. The height of the water in the gauge may also, if desired, be tested by thus blowing out the water, measuring its amount, and calculating its height for the known capacity of the cylinder.

## RAILWAY DRAWBRIDGE AND SWITCH SAFETY TELEGRAPH.

— MCRAE, *Inventor.*

The object of this apparatus is, to give to the conductor of a railroad train, when approaching a drawbridge or switch, a signal by which he may know that the bridge or switch is in the right position to pass the train with safety. To accomplish this, an electric current is established from a battery, including in it the drawbridge or switch, so that if these be in proper position, the circuit is complete at that point, but that if they be out of position, the circuit is there broken. The zinc which forms the conductor terminates at a safe distance from the bridge or switch, in a carefully insulated rail; and the next rail, also carefully insulated, is connected with a ground-plate, by which the circuit is completed. An ordinary electro-magnet is placed upon the locomotive, its armature so adjusted as to control the sounding works of an alarm, and the extremities of its coils terminating, the one on the front, the other on the hind axle of the locomotive. Then it is evident that the electric circuit is broken at the insulated rails, but that when the locomotive reaches that point, the front wheels being on one, while the hind wheels are on the other insulated rail, the circuit will be completed, and the bell sound, provided the drawbridge or switch be in a proper position; but that if they should not be so, then the bell cannot sound, for the armature will not be attracted, in consequence of the circuit being broken at the bridge or switch. It will be observed here, that the indication to the conductor that he may proceed is given by an actual audible signal, and that this signal cannot be given by any accident. The only effect of the apparatus getting out of order or not working, is to make the conductor proceed cautiously. It will also be seen, that if it be found necessary in practice, the insulated rails in which the parts of the circuit terminate may be separate from the track, and placed inside or outside of it; the connection with the engine being made by metallic springs at its front and back, projecting downwards so as to press upon them.

A modification of the above apparatus is proposed to prevent collisions on single tracks. In this case, a double circuit is established from the same battery to the turn-out, at the extremities of the part of the track on which the trains may meet. The lines here terminate by circuit-changers, by which all current is stopped while the apparatus is not in use. The conductor who first arrives at either end of this prepared track shifts the changer, by which means he establishes the circuit from the other end through his magnet, and if everything is right, gets the signal that he may go on, leaving the changer as he placed it. Then when the other train arrives at the opposite end, he cannot complete a circuit, because his circuit must come from the other end, and has been already broken by the first conductor; he therefore knows that the other train has passed the next turn-out, and must wait until it passes him. Each conductor, as he passes off the prepared track, places the circuit changer of that end in its first position, and the apparatus is ready for service again. It will be seen that these changes may be easily done, if desirable, mechanically by the engines themselves. And here, again, the derangement of the apparatus can only result in additional caution on the part of those in charge.

## McCONNELL'S EXPRESS LOCOMOTIVE.

SIR—In the *Practical Mechanic's Journal* for this month (December,) there is published some account of McConnell's Locomotive, with an illustrative plate, in continuation of previous articles on the same subject in that journal. As the writer has, in my opinion, misapprehended the merits of that engine in various respects, and as it is of importance that the public should not be misled by *ex parte* statements in questions of locomotive power, which materially involve the pecuniary interests of railway companies, I beg the favour of your columns for the insertion of the following observations, with a view to the proper discussion of the subject of Express Locomotives, and the establishment of correct principles in their design and construction.

In the article in question it appears to have been overlooked that McConnell's engine was investigated at the Institution of Civil Engineers, on the reading of my paper on "Locomotive Boilers," in March last, and subsequently in the joint Report of Mr. Edward Woods and Mr. William P. Marshall to the General Locomotive Committee of the London and North Western Railway Company. It was on both of these occasions proved that the new engine was radically wrong in all its boasted peculiarities, and that Mr. McConnell had disregarded the lessons of experience, whether in respect of the boiler, the engine, or the whole machine as a carriage.

And, first, of the boiler. Mr. McConnell, and, with him, the writer in the *Practical Mechanic's Journal*, started with two grand fallacies,—one was, that the fuel was imperfectly consumed in ordinary passenger-engines, and the other was that firebox surface is in itself superior to tube surface for the absorption of heat. I might very properly add a third fallacy, by which they were misled; namely, the assumption that the area of grate has no economical relation to the heating surface. Now, in respect of the combustion of coke in the locomotive firebox, I showed in my paper, from direct experiment, and by reference to the heat-properties of the gases of combustion, that the combustion was practically perfect, and that the immense, useless, and costly chambers of the patent firebox, and its perforated stays for the admission of air, were not only useless, but injurious; and these deductions were confirmed by most of those who took part in the discussion, while not even a show of reason for doubting their validity was sustained. But I am happily relieved from the necessity of insisting further on this point, by the evidence of two such authorities as MM. Ebelmen and Sauvage, who, shortly after the discussion on my paper, undertook a series of experiments on the engines of the Lyons Railway, the object of which was the analysis of the gaseous products of combustion discharged into the smoke-box. They found that in the passenger engines, there might be too much air admitted, but there *never was any carbonic oxide gas*; the whole of the carbon constituting the fuel was converted into carbonic acid, and this constitutes the complete combustion of coke. The two investigations, then, founded on the observed evaporative duty of this fuel, on the one hand, and the chemical analysis of the gases in the smoke-box, on the other hand, pleasingly confirm each other, and demonstrate the futility of the smoke-and-air mixing expedients devised by Mr. McConnell for his express engines. Again, as to the firebox surface, I do not know on what grounds Mr. McConnell asserts its superiority to tube surface; surely the tubes, ⅛-inch thick, may conduct the heat to the water at least as readily as the ½-inch walls of the firebox. It would perhaps, occupy your pages at too great length to go into the experimental evidence on this question; but the evidence of all genuinely-recorded experience shows that the distinction claimed by Mr. McConnell exists nowhere but in his own brain.

But Mr. McConnell has utterly forgotten, or, perhaps, has never understood, the essential relation that subsists between the grate-area and the heating surface. It is clear he had no suspicion that the larger he made the grate, beyond what was required for the complete and proper combustion of the fuel, the less efficient was the fuel for evaporation, on account of the inferior intensity of the heat of combustion, and the inferior rate of absorption of the heat. If he would only make his firebox large enough, he would find, bye-and-bye, he should get no steam at all; the production of steam would, in fact, be inversely as the bulk of his engine.

We are told, I know, and well told too, that his engine gets up the steam in a wonderfully short time; and he, with pardonable partiality, ascribes the prompt action of the boiler to the vastness of the firebox-surface. No such thing; it is connected simply with the very small water-room of the boiler, in which of course there is little water to be heated; and it is due also to the largeness of the grate, and to the shortness of the tubes, which thus offer little resistance to the draft. For these reasons it was, that the *Rocket*, in 1829, got up her steam in even less time than McConnell's engine. While on this point, I may allude to the injuriously narrow water-spaces, only 2 inches wide, round the "combustion chamber," and at the sides of the firebox. Mr. McConnell may rely upon it, that much of the inferiority of his engine is referable to the narrowness of the water-spaces, which baffle the ascent of the steam; it is certain that the throat of the "combustion chamber" will speedily burn out from this very cause, and entail costly repairs.

Referring, finally, to the actual evaporative power of this engine, it was distinguished for nothing but its mediocrity. With its contracted blast-pipe and wide air-space of grate, it did not boil off 190 feet of water per hour, and this at the rate of only 8 lb. of water per pound of coke, of which nobody knows how much was due to priming, with the cramped water-ways and steam-room; whereas the *Great Britain* broad-gauge boiler evaporates,—with smaller exterior dimensions than those of McConnell's engine,—half as much again, with the same ratio of water to fuel; and there are many boilers of half the size which will do as much work as this leviathan, with equal efficiency. It is true, a comparative trial was made with other engines, in which McConnell's engine is made out to have given the best result. But the trial was not properly one of locomotives as a whole, but of boilers; and it should have been stated, that, in these very trials, the *Heron* and *Prince of Wales*, of the Northern Division, evaporated 8·35 lb. of water per pound of coke, while the large engine raised only 7·99 lb. per pound of coke; and moreover, the fires were improperly lighted in the smaller boilers, as the steam, usually got up in one hour, occupied on the occasion of the experiment, about three hours in getting up, and even then the fuel was imperfectly kindled. These mishaps may readily arise from the admission of small rubbish into the firebox; and as the steam was got up under the charge of Mr. McConnell's assistants, at Wolverton, contrary to the laws of experimental justice, it is perhaps not very difficult to imagine a reason for the mishap.

Now, as to the engine. The leading dimensions are merely copied from those of the Great Western engines. An eight-feet wheel on the narrow gauge is sheer absurdity,—it is worse, for the larger the wheel, the larger must be the cylinder, or the higher the working steam pressure; and consequently the greater the strain on the working parts, and the probability of overheating the bearings, and breaking down the crank-axle. A six-feet wheel is quite large enough for a narrow-gauge express engine: it admits of a free exhaust, it sufficiently moderates the reciprocations, it moderates the direct strains on the machinery, it admits of a sufficiently wide blast-orifice, and it moderates the total weight of the machine, as the cylinder and other mechanism may be correspondingly moderate.

Lastly, as to the carriage, or the machine as a vehicle. It is difficult to conceive how Mr. McConnell could permit himself to fall into the error of making a 31-ton engine for express trains. The weight is enormous: to quote the language of the writer of the article in question, "as the road exists at present, it is simply impossible to run the London and Birmingham two hours' expresses with any reasonable degree of safety." And yet this 31-ton engine was deliberately designed for that very purpose, now declared impossible to accomplish. Nor could the blunder possibly have been committed in ignorance of such consequences, for, in 1849, the attention of the General Works Committee of the London and North-Western Railway was forcibly directed to the very question of heavy engines *versus* the capacity of the road to sustain the loads; and in the Report to that Committee, signed by Mr. McConnell in conjunction with other officials appointed to investigate the subject of Permanent Way, and published in 1849, it was admitted that the question of heavy engines and high speeds, was one of considerable embarrassment in its engineering aspects. "It is no longer a matter of argument," say they, and amongst them Mr. McConnell, "that the increased weight and speed of the engines and trains, has become very marked; and the *concurrent testimony of those who are engaged in the practical part of the repairs*, proves that the deterioration of the road has increased very rapidly since the period of the introduction of the heavy engines. There is no longer a doubt that *the immoderate damage to both the road and the stock from high speed,* outweighs, in positive loss to the Company, the additional fare received, if it does not far more than counterbalance any solid advantage *derived from it by the public*." (see Report p. 37). Since 1849, the causes of deterioration have been undiminished, indeed necessarily increased, for, in April 1853, the Permanent Way Committee not only admit that there has been an unanticipated increase in the cost of the maintenance of way, but they estimate that the probable "life" of the rails, notwithstanding the increased outlay in maintenance, is, on account of the probable increase of traffic, and of the weight of the engines, *reduced from* 20 *years to* 15 *years*; that is, the duration of the rails is diminished 5 years, and the road, though absolutely stronger than before, is now relatively weaker by 25 per cent. In the face of such accumulated evidence, then, is it surprising that McConnell's engine should have been found so destructive to the road as to have been prohibited from the running of express trains? The wonder is that the idea of such an express engine should ever have been seriously entertained by the Directors.

I have, I think, shown that in the chief patent points, McConnell's Express (?) engine is a failure, in so far as it is in any respect in advance of its predecessors on the rail. If, indeed, it was only equal to others—if it even attained the summit of mediocrity, it might have escaped censure, as it would have escaped notice. I do not deny that it is a remarkable engine, but it is remarkable only for its inferiority; and this is something to say, where thousands of pounds of expenditure are involved. I have shown that the inventor, Mr. McConnell,—if inventor he can justly be called, when not one of all the patent peculiarities originated with him,—I have shown that he has contemned the accumulated experience of others, whether in the boiler, the engine, or the carriage. But nature's laws may safely be left to themselves, as they are sure to find out and duly to correct the aberrations of ignorance and folly.

I had proposed to offer some remarks on what appeared to me the true course of improvement in respect of express engines and trains; but I am precluded by the length of this communication, from venturing to occupy your columns further at present.

D. K. Clark.

1a, *Adelphi Terrace, London,*
*December* 16, 1853.

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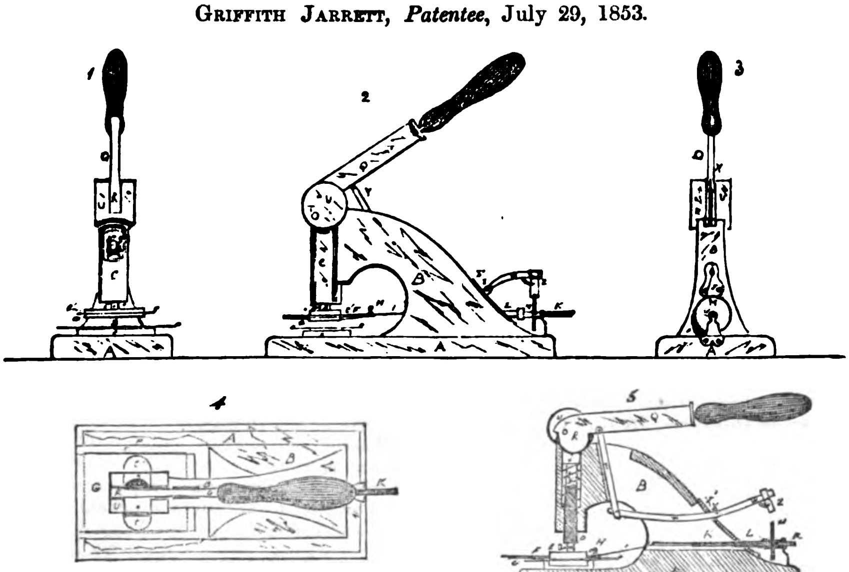
## PRESS FOR PRINTING IN COLOURS WITHOUT FLUID INKS.

Griffith Jarrett, *Patentee*, July 29, 1853.



The very general objection to endorsement stamps, &c., where fluid ink is used, from the inconvenience incident upon the drying or caking of the ink, which renders the production of a correct or satisfactory impression so uncertain, has induced the patentee of the above press to substitute carbonic or other chemically prepared paper or material for the ordinary printing inks. The apparatus is self-acting, adapted for the desk, counter, or writing-table; it is also very portable, and easily worked by the hand—the stamping action of the machine brings continually a fresh supply of colouring matter to the die or type, so that there is no interval of time wasted between the successive impressions; and the press is always ready for use.

Fig. 1 shows a vertical front view of the apparatus, fig. 2 a side elevation, fig. 3 an end elevation, fig. 4 a top or plan view, and fig. 5 a longitudinal elevation. (In each figure the same letters of reference denote similar corresponding parts).

A A, the pedestal or stand; B B, bracket arm or standard; C C, cylindrical head, for receiving and directing the movement of the die or type fount C; D D, slide or pressure bolt, working vertically within the cylindrical head upon which the die or fount is fixed or secured by means of the tightening screw E E; F F, traversing frame, upon which the chemically prepared paper or material for colouring is stretched or laid; G G, the chemically prepared paper or material; H H, tightening screw, for attaching or detaching the frame to insert or remove the said paper or material for colouring when required; I I, elastic bar or spring, by which the traversing frame and the chemically prepared paper or material are kept up horizontally against the die or fount and allowed to yield to its pressure in descending; K K, screw for traversing the frame working in hollow rectangular bearing L L, fitted to the stand or pedestal; M M, revolving nut and wheel, capable of moving in opposite directions, to give a backward or forward motion to the screw, and corresponding action to the frame; N N, leather pad or bed upon which the die or type is pressed; O O, metallic plate, for holding or retaining the same; P P, the paper or surface for receiving the coloured impression; Q Q, stamping or pressing lever, formed or fitted with eccentric or cam-head R R, for giving the required pressure to the die; S S, slide or bolt head, hollowed out so as to give a peculiar facility to the eccentric action of the cam R R; T T, pen or stud on which the stamping lever works; U U, lever boss; W, a spiral spring for retaining the die in a reacting position; W W, the curved motion lever working on the centre X, secured to the fixed plate X′; Y Y, the connecting link uniting the stamping lever and the curved motion lever; Z Z, small shifting tappet or paul, acting on the revolving nut wheel M, at intervals consequent upon the raising or lowering of the stamping lever; the tappet admits of being turned or adjusted so as to take into the teeth on either side, and actuate the nut and wheel in contrary directions, so as to give the screw K, and the frame F, a backward or forward motion. *The press is put in action* by simply pressing down the die or type through the medium of the stamping lever in connection with the slide or pressure bolt D; the die or type being thus caused to descend carries down the traversing frame and chemically prepared paper or material which is thus pressed against the paper or surface to be printed, producing a coloured impression thereon, at the same time that the short arm of the curved motion lever becomes elevated (as shown in fig. 5). The impression being made, the stamping arm of the eccentric lever is raised to its original position by the spiral spring V; the short arm of the curved motion lever W, is then depressed, and the shifting paul Z, pressing against the toothed wheel M, turns it partially round, thus carrying forwards or backwards the screw K, and the frame F, and exposing a fresh surface of the colouring paper or material to the action of the die or fount in readiness for the next operation. After the frame has traversed its whole distance, its motion is reversed by simply turning the tappet or paul Z. When the colouring matter on the chemically prepared paper or material is exhausted, a fresh piece is slipped on the frame.

## LIST OF PLANS DEPOSITED AT THE PRIVATE BILL OFFICE FOR SESSION 1854.

*Railways.*

Ambergate, Nottingham and Boston, and Eastern Junction Railway (Extension of line into Nottingham).
Ayr and Maybole Junction.
Bagnalstown, New Ross, and Wexford.
Ballymena, Ballymoney, Coleraine, and Portrush Junction (No. 1).
Ballymena, Ballymoney, Coleraine, and Portrush Junction (No. 2).
Barnard Castle and Bishop Auckland Junction and Branch.
Belfast and County Down.
Belfast and West of Ireland Junction (Armagh to Cavan).
Belfast and West of Ireland Junction (Armagh to Clones).
Blyth and Tyne (Extensions to Tynemouth, &c.)
Blyth Harbour Improvement Dock and Railway.
Border Counties (North Tyne Section).
Bradford, Wakefield and Leeds.
Caledonian (Lismahago Branches).
Caledonian (Alteration of Wishaw and Coltness Railway, &c.)
Cannock.
Carlisle and Silloth Bay Railway and Dock.
Carmarthen and Cardigan.
Caterham.
Clones and Cavan Junction.
Congleton and Biddulph Valley.
Conway and Llanrwst.
Cork and Bandon.
Cork, Blackrock, and Passage.
Cork and Waterford (with Branch to Fermoy).
Darenth Valley (Extension to Sevenoaks).
Darlington and Barnard Castle.
Dartmouth, Torquay, and South Devon Extension.
Derbyshire, Staffordshire, and Worcestershire.
Direct Southern Railway and Thames Terminus.
Dover and Canterbury and Dover and Deal (East Kent Extension).
Dowlais (Extension, &c.)
Downpatrick, Belfast, and Dublin.
Dublin and Wicklow (Extension to Woodenbridge).
Dundalk and Enniskillen (Branches to Cavan and Armagh).
Eastern Counties (Station Enlargement, Wisbech Branch).
East Lancashire (Dock Branch and Lines at Liverpool, &c.)
East Lancashire, Lancashire and Yorkshire, and Manchester and Southport.
Eastern Union (Branches to Wymondham and Eye).
Eastern Union (Woodbridge Extension Line, &c.)
East Suffolk.
Exeter and Exmouth.
Ffestiniog.
Ffestiniog and Machno.
Grand Junction of Ireland.
Great North of Scotland.
Great Southern and Western (Extension to Athlone).
Great Western (Berks and Hants, &c.)
Great Western (Stratford Line, &c.)
Havant and Hayling.
Hertford, Ware, and Welwyn Junction.
Horncastle and Kirkstead (Great Northern) Junction.
Inverness and Nairn.
Irish South-Eastern.
Kilkenny and Great Southern and Western.
Kinross.
Lancashire and Yorkshire (Middleton Branch).
Lancashire and Yorkshire (Liverpool Dock Branches).
Leamington, Warwick, and Stratford-upon-Avon.
Leeds, Bradford, and Halifax Junction.
Leicester-square Junction Railway and Southwark Improvement.
Leominster and Kington.
Llanidloes and Newtown (Extension from Llanidloes to Llangurig, &c.)
Llynvi Valley.
London and North-Western (Crewe and Shrewsbury).
London and North-Western (Haydon-square).
London and North-Western (Shrewsbury and Newtown).
London and Oxford.
London and West Kent.
London, Brighton, and South Coast.
London, Tilbury, and Southend Extension.
Londonderry and Coleraine (Castledawson Extension &c.)
Londonderry and Enniskillen.
Londonderry and Enniskillen, and Londonderry and Coleraine.
Lymington and Brockenhurst Junction.
Mallow and Fermoy.
Midland Great Western of Ireland (Tullamore Branch).
Montgomeryshire and Red Valley.
Newport, Abergavenny, and Hereford (Extension to Swansea, &c.)

*Railways—*

Norfolk (Aylsham Branch).
Norfolk (Lowestoft Harbour Improvement).
North and South Wales.
North London.
North Metropolitan.
North Yorkshire and Cleveland.
Nuneaton, Hinckley, and Leicester.
Oxford, Sevenoaks, and Tonbridge.
Oxford, Worcester, add Wolverhampton (Chipping Norton Branch).
Oxford, Worcester, and Wolverhampton (Cradley Loop Railway).
Oxford, Worcester, and Wolverhampton (Stratford-upon-Avon and Stourbridge Branches, &c.)
Perth and Dunkeld.
Portsmouth.
Potteries, Biddulph, and Congleton.
Rhymney.
Rugby and Oxford Junction.
Salisbury and Yeovil.
Selkirk and Galashiels.
Severn Valley.
Shrewsbury and Chester.
Shrewsbury and Hereford.
South Devon (Alterations, &c.)
South Devon and Tavistock.
South Eastern (Lewisham to Bromley, &c.)
South London.
South Metropolitan.
South Midlands Union.
South Staffordshire.
Southwark and Crystal Palace.
South Wales (Branches, &c.)
South Wales and Northamptonshire Junction.
Spalding, Bourn, and Stamford Junction Railway, and Spalding Waterworks.
Stockport, Disley, and Whaley Bridge.
Stockton and Cleveland Union.
Stockton and Darlington (Branches to the Shildon Tunnel, &c.)
Swansea Bay and Loughor Valley Mineral Junction.
Swansea Vale.
Sydenham, Farnborough, and Otford.
Thames Embankment and Railway (London and Westminster).
Thames Embankment and Railway (London to West London Railway).
Torquay aud South Devon Extension.
Tottenham and Hornsey Junction.
Tramore and Dunmore.
Tuam.
Vale of Towy.
Wells and Fakenham.
West End of London and Crystal Palace (Extension to Bromley and Farnborough).
West End of London and Crystal Palace (Branch to Wandsworth).
West Kent and Crystal Palace Junction.
Westminster Terminus.
Wexford and Wicklow Junction.
Whitehaven (Cleator and Egremont).
Wrexham and Ruthin.
Wycombe and Oxford.
York and North Midland.
York, Newcastle, and Berwick (Construction of Docks, &c.)

Total number of Railway Plans, 135.

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*Miscellaneous.*

Abergavenny Improvement.
Aboyne to Ballater and Tarland Turnpike Road.
Accrington Gas and Water Works.
Albert Park.
Ashton-under-Lyne and Dukinfield Bridge.
Bacup Improvement.
Bangor Waterworks.
Bannow Reclamation.
Beccles Water and Gas.
Belfast Harbour.
Bideford Roads.
Birmingham Canal Navigations.
Blackburn Improvement, &c.
Bolton Improvement.
Bowling Waterworks.
Bradford Corporation Waterworks.
Bradford Waterworks.
Brighton, Hove, and Preston Constant Service Waterworks.
Burnley Improvement.
Charing-cross Bridge.
Cheltenham Waterworks.

*Miscellaneous*—

Chester Corporation Waterworks.
Chester, Farndon, and Worthenbury Road.
Chesterfield Waterworks and Gas.
Clitheroe Waterwoks.
Coleraine Waterworks.
Commissioners for the Exhibition of 1851 (Kensington Gore Road, &c.)
Commissioners of Sewers for Levels of Havering, Dagenham, &c.
Crystal Palace Company (Power to divert Roads, &c.)
Darlington Local Board of Health.
Devonport Dockyard, and Keyham Steam Factory Yard Tunnel.
Edinburgh Police and Improvement.
Enniskillen Waterworks.
Ennis and Shannon Navigation (No. 1).
Ennis and Shannon Navigation (No. 2).
Glasgow Corporation Waterworks.
Glasgow New Street.
Glasgow New Suspension Bridge.
Gloucester Water.
Great London Drainage.
Greenwich and South-Eastern Docks.
Hamilton Waterworks.
Hatfield Chase (Incorporation of Company, &c.)
Hereford Improvement.
Kensington Improvement Act (1851) Amendment.
Kingstown Gravitation Waterworks.
Lady's Island Embankment.
Lea Water, Sewage, and Navigation Company.
Leeds Waterworks.
Liverpool Improvement.
Llandudno Improvement.
Londonderry Bridge.
Louth Waterworks.
Lowestoft Improvement.
Manchester Corporation Waterworks.
Manchester Improvement.
Metropolis Improvements (New Street from Bell-yard, Carey-street, to Fetter-lane).
Metropolitan Commission of Sewers (Deptford Pumping Station).
Newcastle-upon-Tyne Docks.
Newport Dock Company.
Newport Improvement.
Newport and Pillgwenlly Waterworks.
New River (Hertford Sewage Diversion, &c.)
New River (New Reservoirs, &c.)
Padiham Waterworks.
Paisley Waterworks.
Penrith and Cockermouth Roads.
Port Gordon Harbour.
Port of Londonderry.
Port and Harbour of Londonderry.
Portsmouth and Gosport Waterworks.
Radstock and Buckland Dinham Roads.
Rossall Estate Sea Wall.
Runcorn Waterworks.
Ryde Improvement (Sewers).
Ryde Improvement (Waterworks).
Saint Mawes Port, Harbour, and Pier.
Shipley Waterworks and Police.
Southport Waterworks.
Stockton, Middlesbrough, and Yarm Water Company.
Stourbridge Waterworks (Incorporation of Company, Construction of Works, and Supply of Water).
Stourbridge Waterworks (for the formation of Waterworks and supplying Water within the Township).
Sunderland Improvement and Municipal Boundaries.
Swansea Harbour.
Tacumshin Embankment.
Thames Improvement.
Traethbach New Bridge and Road (No. 1).
Traethbach New Bridge and Road (No. 2).
Trowbridge Roads.
Wandle Sewerage and Water Company.
Warrington Improvement and Market.
Waterford Improvement.
Waveney Valley Drainage.
Wellington Docks (Southwark).
West Bromwich Improvement, Sewers, Market, and Cemetery.
Weymouth and Melcombe Regis Markets and Pier.
Whittle Dean (Newcastle-upon-Tyne) Waterworks.
Yeovil Corporation and Borough Improvement.

Total Number of Miscellaneous Plans, 98.

## PARTICULARS OF THE U.S. STEAMER 'GOLDEN AGE.'*

Hull built by Wm. H. Brown; machinery by the Morgan Iron Works. Intended service, Australia.

| | | |
|---|---|---|
| **Hull—** | | |
| Length on deck | | 270 feet |
| Breadth of beam, at midship section above main wales | | 43 ,, |
| Depth of hold | | 24 ,, 4 inches |
| Length of engine and boiler space | | 92 ,, |
| Draught of water at below pressure and revolutions | | 14 ,, 9 ,, |
| Area of immersed midship section at this draught | | 552 square feet |
| Capacity of coal bunkers, in tons of coal | 600 | |
| Draught of water at load line | | 17 feet |
| Floor timbers at throats, moulded | | 18 inches |
| Floor timbers at throats, sided | | 12 ,, |
| Frames, distance apart at centres | | 36 ,, |
| Masts and rig | Barque | |
| Tonnage | 2376 tons | |
| **Engine—** | | |
| One vertical beam | | |
| Diameter of cylinder | | 83 inches |
| Length of stroke | | 12 feet |
| Maximum revolutions per minute | 16 | |
| **Boilers**—Two double boilers, drop flue, with furnace at each end, and one connection in the centre. | | |
| Length of boilers | | 38 feet |
| Breadth of boilers | | 14 ,, 9 inches |
| Height of boilers, exclusive of steam chimney | | 12 ,, |
| Number of furnaces in both boilers | 16 | |
| Length of grate-bars | | 6 ,, |
| Number of flues | (main flue) 8 | |
| Internal diameter of flues | | $16\frac{7}{8}$ inches |
| Diameter of smoke-pipe | | 8 feet 4 inches |
| Height of smoke-pipe | | 41 ,, |
| Maximum pressure of steam in pounds | 25 | |
| Description of coal | Bituminous | |
| Consumption of coal per hour | $1\frac{7}{8}$ tons | |
| Area of flue and fire surface in boilers | | 5854 feet |
| **Water Wheels—** | | |
| Diameter | | 34 feet 6 inches |
| Length of blades | | 9 ,, 6 inches |
| Depth of blades | | 1 ,, 11 inches |
| Number of blades | 28 | |

*Remarks.*—Strapped with diagonal and double-laid braces, $5 \times \frac{3}{4}$ inch; coppered

* From the Journal of the Franklin Institute.

## INDURATING STONE AND OTHER BODIES.

Barnabas Barrett, *Patentee*, April 30, 1853.

This invention relates to certain means of indurating stone, cement, plaster, and other like porous bodies, and thereby giving them the property to resist moisture, and also, in some cases, improving their appearance as well as increasing their durability.

It has hitherto been the practice in indurating stone, &c., to subject it to a very high degree of heat, in order to make the indurating substance penetrate and permeate through the material. This, however, has been found highly detrimental to the material under operation, and in many cases has failed to produce the desired effect. To remedy these evils it is proposed (in all cases where it is practicable), in applying these indurating mixtures, to enclose the stone or other materials to be operated upon in an air-tight chamber, and exhaust or partially exhaust the same; and then allow the indurating substance, whether hot or cold, to trickle down or flow into the chamber to fill the vacuum; the effect of which will be that the liquid indurating substance will readily find its way into the pores of the stone or other material, and become incorporated therewith.

Before subjecting the materials to this process of injection, they must be heated in a chamber or oven, to from 50° to 60°, for the purpose of driving out whatever moisture they may contain; and as the process greatly increases the natural tenacity of the materials submitted to such treatment, the articles should be worked or fashioned to their required form before being thus operated upon.

When the materials or works of art require to be coloured, they are stained with any suitable vegetable or mineral colour, by laying the same on with a brush, and allowing the colour to dry before commencing the indurating process.

*Mixture No.* 1.—the composition of this solution is as follows: —56 parts, by weight, of sulphur, dissolved by the aid of steam heat or dry heat, in 44 parts of dilute vinegar or acetic acid, containing 17 parts of acid to 8 of water.

In preparing indurating mixtures, to be applied to the exteriors and interiors of buildings, whether possessing a surface of brick, stone, cement, or plaster, the following ingredients are employed:—

*Mixture No.* 2, contains shellac, 14 parts, by weight; seed-lac, 14 parts; coarse turpentine, 1 part; pyroligneous spirits, 40 parts.

*Mixture No.* 3, is composed of gutta-percha, dissolved in coal-tar, naphtha, or other suitable solvent, in the proportion of 3 parts, by weight, of gutta-percha, to 8 parts of the solvent.

*Mixture No.* 4. The proportions and ingredients of this mixture are as follows:—To 1 bushel of limestone or chalk add 12 gallons of water and 12 lb. of alum, half a gallon of beer grounds and half a gallon of gall, and mix the same well together. If it is desired to colour the mixture, this may be done by adding thereto pitch, or vegetable or mineral colours. These solutions, when made lukewarm, may be laid on with a brush, until the surface treated will absorb no more. Works of art, blocks of stone, and other detached porous materials of the kind specified, may also, with advantage, be indurated by the use of these mixtures.

*Claim.*—Hardening and colouring natural and artificial stone, and articles composed of porous cements or plaster.—*Newton's London Journal.*

## THE TIME BALL, EDINBURGH.

By Professor C. Piazzi Smyth.

At the meeting of the Royal Scottish Society of Arts, on 12th Dec. 1853, Professor Smyth, at the request of the Council, gave an interesting exposition of the Time-ball recently erected on Nelson's Monument in connection with the Royal Observatory of Edinburgh. After alluding to the praiseworthy exertions of the late Astronomical Institution for the purpose of communicating the true time to the public, and the successive steps since taken by the Government in furtherance of those views, the Professor mentioned the time-ball as the last addition that had been made. The principle of this method of publishing the true time—viz., by the sudden dropping of some large and heavy body—was due to Captain (now Admiral) Wauchope, who, about 1829, frequently memorialised the Admiralty on the subject, and was at length rewarded for his trouble by seeing the erection of the signal, so useful to navigators, at the Greenwich Observatory. Within a few years after, such was the practical advantage found in consequence, that similar time signals were adopted at Portsmouth, Madras, St. Helena, and the Mauritius; and Captain Wauchope himself going out to the Cape station on duty in 1835, succeeded before long in having a time-ball established at the Observatory there. The Professor stated that he had had several years' personal experience (between 1837 and 1845) with this ball, or balls, for several were made, and literally used up, so difficult was it found with more simple workmanship to secure the perfect action which Mr. Field, of the firm of Maudslay and Field, had obtained by the adoption of a cylinder of compressed air, to break the force of the ball's descent. In 1841, when the Edinburgh Observatory was in full astronomical activity, and everything but the machinery of a time-ball possessed, the erection of one was agitated for by Admiral Milne, Captain Basil Hall, Captain Dall, and others, but unfortunately without success. In 1846, another attempt was made; for having had the honour of being appointed to the direction of the Edinburgh Observatory, and having received many representations from Sir T. Makdougall Brisbane, and others, of the urgent importance to Edinburgh and Leith of the establishment of a time-ball, he (Professor Smyth) reported the same to the Secretary of State for the Home Affairs. Soon after, Captain Washington, R.N., and Captain Veitch, R.E., Tidal Harbour Commissioners, were appointed to examine and report on the case; and they did make a minute examination of the locality and the interests of the inhabitants concerned, and strongly recommended the measure; but yet, strange to say, it was ignored by higher authorites. But the necessity for the erection of a time-ball by no means decreasing with these official difficulties, as the representations of the Edinburh and Leith Chamber of Commerce continued to show, he brought the matter forward again in 1848, in the printed report addressed to the then recently appointed Board of Visitors of the Royal Observatory. The Board seeing the importance of the subject, took it up warmly; the President, Professor J. D. Forbes, in the following spring in London waited on the then Lord Advocate (the Hon. Lord Rutherfurd), who, already much interested in the subject, immediately advocated it so powerfully in the Treasury, that it was forwith ordered to be undertaken, on the necessary estimates having been procured from Parliament. The procuring of the ball, with the money so obtained, was put into the hands of the Office of Woods and Forests; and they knowing well how admirably the Greenwich time-ball had performed, applied to Mr. Field to make a similar one tor Edinburgh, with all the additional improvements that had been suggested by the Astronomer-Royal, Mr. Airy, who took much personal interest in the execution of this new machine.

Professor Smyth then proceededto describe the apparatus—The ball is 5 feet in diameter, is painted black, and rises and falls through 10 feet. To annihilate the effect of the varying friction between the ball and the mast on which it slides as caused by the greater or less side pressure of wind, it is made very heavy, say 15 cwt. The celerity and certainty of the first part of its descent (all that is required for the observation) is thus ensured; while the latter part is effectually checked through the action of the air cylinder; a tube, which, closed below, receives a piston on the end of a long staff attached to the lower side of the ball, and being pretty nearly air-tight, affords at last so complete a resistance, that the ball in the piston is brought to a stand in the air, before it strikes any solid body. By opening and closing a small stop-cock below, the strength of this air-spring admits of very nice adjustment; for, when completely closed, the ball is thrown back half-way up the mast again; while, when fully open, it comes down with the report of a cannon. The ball is raised by crank-wheel-work acting on a pinion, which can be put in or out of gear with a rack edge on the ball-staff; and when the ball is raised up to the cross pieces on the top of the mast (its first descent from which is the instant of the fall to be observed), the piston, a mere iron disc, rendered close fitting by a plentiful lubrication of tallow, is lifted clean out of the cylinder about two feet, so as to offer no friction to oppose the rapidity of the first part of the descent. Again, to this end, the detents which hold the ball up when on high, and by whose movement it can be dropped, are made to catch into hooks on *either* side of the staff, and to work precisely together by a toothed-sector gearing, so that there may be no side pressure of the great weight then in suspension. Still although the detents and hooks are made of polished steel, there is more friction needed to loose them than a magnet could well overcome, especially as it would have to act through a considerable distance, from the touching surfaces of the supporters being made long enough, 0·5 inch, to guard against the vibration of the ball and staff in a high wind. But if, as is found, 1·200 or 8 lb. will pull the trigger of, and drop the big ball, then 1·200 of 8 lb. will be enough to drop a little ball of that weight, inside the apparatus; and it may be made to fall on the trigger of the other and drop that. This is the plan adopted, and as this smaller, or dropping ball, is not exposed to the wind, a very slight notch serves for its trigger, and a moderate magnet suffices to free it.

The electro-magnets are two in number, of the horse-shoe form, surrounded by close coils of fine wire covered with silk, and further saturated with wax, to guard against the damp of the top of the monument, and the communicating wires, covered with gutta-percha, pass down the side of Nelson's Monument in a wooden casing, and thence underground in iron pipes to the Observatory, where they rise through the floor, and are connected with the voltaic batteries and the contact maker on the case of the transit-clock. The contact maker is a very delicate sort of finger-note of brass, armed with a platinum-point, touching a platinum-plate on slight pressure; and this being within a few inches of the face of the transit-clock, beating its seconds audibly, enables a person to drop the ball on the top of the monument to a degree of accuracy of certainly less than the quarter of a second.

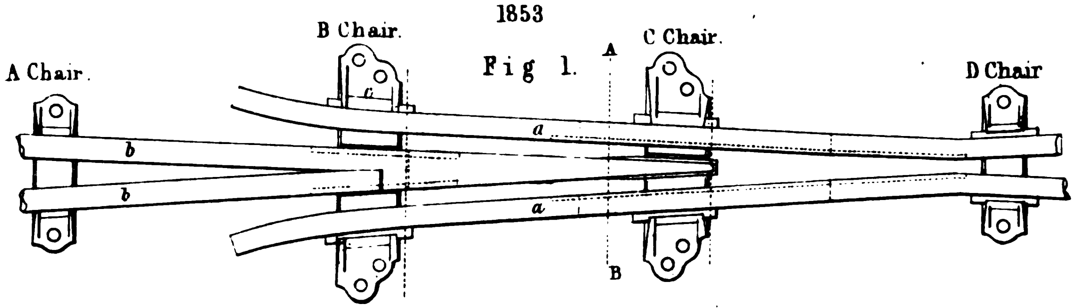
Such, then, is the signal-ball apparatus, as fitted up by Messrs Maudslay and Field, and very effective it is, as far as it goes; but the official use of it has not yet begun, though it is being experimentally dropped every day at one P.M. The reason is, partly, that the Observatory has not yet two disposable persons,—one to

# IMPROVEMENTS IN RAILWAY CROSSINGS AND CHAIRS.

Henry Carr, C.E. Patentee.

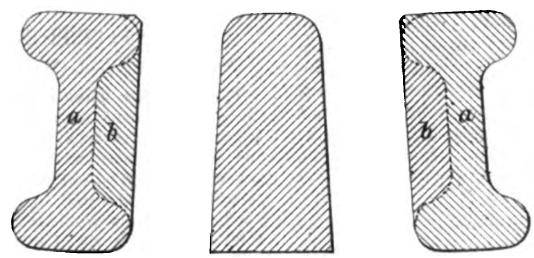
1853

Fig 1.




Plan of an Acute Crossing

Fig 2.




Section on the Line A.B. Fig 1.

Fig. 3. B Chair.

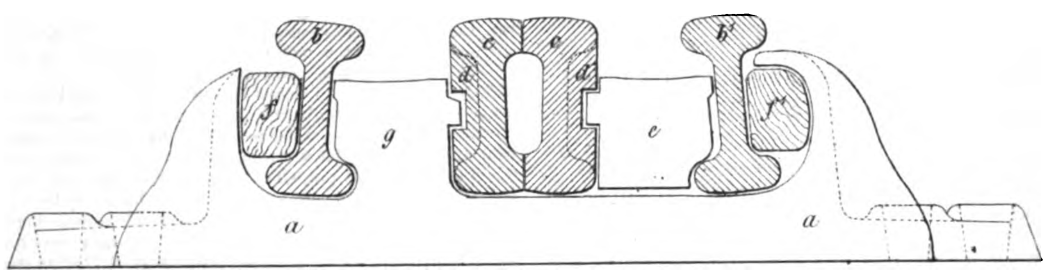
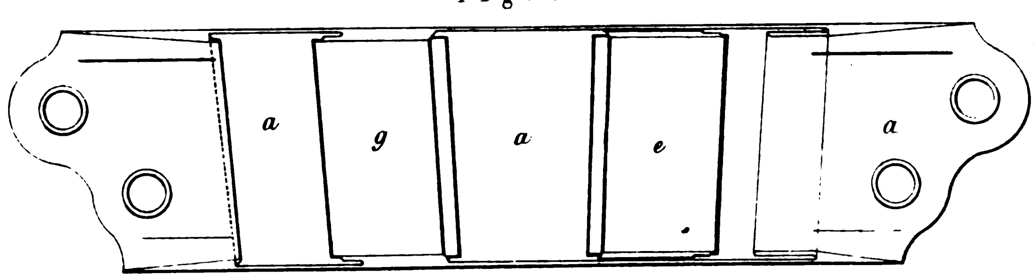
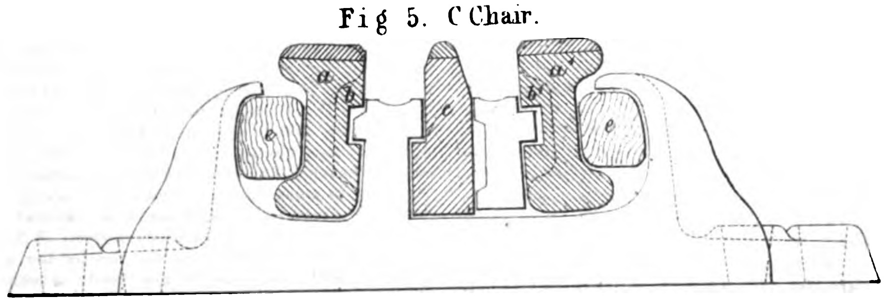



Fig. 4




Plan of B Chair.

Fig 5. C Chair.



go to the top of the monument to wind up the ball, and another to drop it from the Observatory by the galvanic touch; part, also, because, although it is possible for a skilful person to drop the ball to a tenth of a second by the present means, still, after the time has passed, there is no record, no certain proof, that he did so,—nothing, in fact, to show whether he made the signal within even one minute of the time. Now, this should not be in a public establishment, especially one where all the previous parts of the operation are so recorded and certified; for the original observation of the stars for determining the error of the clock in the Edinburgh Observatory are published, together with all the steps of the calculations and ascertainment of the instrumental adjustments by which the clock error is at length obtained to the minute fraction required for astronomical purposes. A plan, however, to obtain this desirable end is in progress, and when in working order, a public notification of the commencement of official responsibility for the accuracy of the time-signal will be made.

The Professor concluded his account by exhibiting to the meeting the action of a model of the time-ball, 9 feet high, made in wood; and which, while keeping all the essential principles of the great time-ball, was altered in shape so as to suit a construction in wood. Inasmuch as in hazy weather our time-ball, even though mounted on the Calton Hill cannot be seen far, it becomes important to know if they can be multiplied cheaply, seeing that when local means are employed to raise them, they can all be dropped by one and the same galvanic touch. Accordingly, it had been found in the present instance, that by transplanting the metal form into the spirit of carpentry, replacing curved forms by straight, and generally adopting a triangular construction, a time-ball apparatus 9 feet high, with ball, windlass, air-cylinder, detents, and hooks, dropping-ball and electric trigger had been lately constructed almost entirely by one man, for 3*l.* to 4*l.*

## RAILWAY CROSSINGS.

HENRY CARR, *Patentee*, April 21, 1853.

(*With an Engraving, Plate* V.)

THE improvements in the construction of crossings of railways consist in—First, forming the inner part of wing-rails of railway crossings solid instead of with an overhanging flange, as in the ordinary crossing of I-formed rails. Fig. 1, Plate V., represents a general plan of an acute crossing, and fig. 2 is a section on the line *a b*, of fig. 1, showing two wing-rails formed in this manner; A, is the common I-rail, and *b*, a filling-piece between the upper and lower inner flanges. This filling-piece prevents the splitting or shearing of the upper flange of the rail where the edge of the wheel bears upon the overhanging part. It may be welded to the rail, or the rail may be rolled or otherwise constructed of the sectional form of the ordinary I-rail and filling-piece combined. The filling-piece is continued to the part of the rail where the wheel first takes its bearing, or as far as is found to be necessary.

Secondly, in strengthening the middle web and overhanging flanges of the point or point-rails by the introduction of the filling-piece above described.

Thirdly, in constructing the two middle chairs of a railway crossing (commonly called the B and C chairs) in such manner that the whole of the rails, when placed in each chair, shall be wedged up by driving in two wooden keys, for the purpose of giving solidity to the point or rails in the chair, and avoiding that motion which causes them to work loose. And for preventing the rails rising from the chairs, there is a fillet cast on the distance-piece, and also a fillet formed on the loose block, which fit into grooves or mortices made in the wing and point rails. Fig. 3 is an elevation of a B chair, with the point-rails, wing-rails, and keys in section; *a*, represents the chair; *b, b*, the wing-rails; *c, c*, the point-rails, strengthened with the filling-pieces *d, d*; *e*, is a loose block or distance-piece, in place of the usual block cast on the chair; *f*, is a wooden key or wedge for tightening the wing-rail *b*; and *f'*, the key for securing the wing-rail *b*, loose block *e*, and point-rails *c, c*, firmly against the fixed block *g*. Fig. 4 is a plan of a B chair, with the rails and wedges removed. Fig. 5 is a view of a C chair, with the wing-rails, point, and wedges in section; *a, a'*, are the wing-rails, with the filling-pieces *b, b'*; *c*, the point; *d*, the loose block or distance-piece, and *e, e'*, the tightening keys or wedges.

Fourthly, in supporting in a similar manner with filling-pieces the upper flanges of switches and stock-rails of the ordinary form, where the wheels bear partially upon the rails.

*Claims.*—1. The construction of the wing-rails of railway crossings with filling-in pieces; 2. The construction of the point of the point-rails of railway crossings with filling-in pieces; 3. The construction of point-rails with filling-pieces; 4. The formation of wing-rails, points, and point-rails of railway crossings by rolling them in one entire piece, of the sectional form of the ordinary I-rail, and filling-piece combined; 5. The formation of wing-rails, points, and point-rails of railway crossings, by forging them in an entire piece, of the sectional form of the ordinary I-rail and filling-piece combined; 6. The formation of wing-rails, points, and point-rails of railway crossings, by casting them of malleable iron of the form of the ordinary I-rail and filling-piece combined; 7. The construction and arrangement of railway chairs with loose blocks and wedges, in the manner above described.

## INSTITUTION OF CIVIL ENGINEERS.

*Nov.* 29, 1853.—J. MEADOWS RENDEL, President, in the Chair.

The discussion being resumed on *"Ocean Steamers,"* it was contended that the statement of a supposed wave pressure of 85,000 tons of water, or even of 40,000 tons, to which it had since been reduced, by a modified estimate, was inadmissible; it would be manifestly impossible for any vessel to withstand such impact from a body of water; and if the position was admitted, it must be evident that any of the ordinary coasting steamers would constantly be liable to a pressure of 1000 to 1500 tons, which would suffice to utterly destroy them.

The comparison of the qualities for safe riding, when lying-to, between a line-of-battle ship and a privateer, was not to the point, as the former was incumbered by the enormous weight of her armament, and by her top-hamper; in short, the whole misconception had arisen from confounding the wave of oscillation with that of translation; this was exemplified by the case of a disabled vessel,—as long as she remained afloat she was comparatively safe, but as soon as she touched the ground, and the wave of oscillation became one of translation, she was immediately knocked to pieces by the impact of the waves.

Next, as to the proportions of 6 to 1, which had been derived from as ancient a type as Noah's Ark,—now, as far as was known, as that construction had not been designed either for sailing or steaming, but only to float with a very large cargo, it afforded no analogy for vessels built for speed, however propelled; and, in fact, modern fast-sailing vessels had abandoned those proportions, which had only been perpetuated by the old tonnage laws, under which merchant vessels were enabled to be constructed to carry enormous cargoes, but they were unable to attain any considerable speed. It was further argued, that as steam propulsion was employed, the analogy became still less apparent; and, as an instance of the advantage of lengthening ships, the case of the vessels belonging to the North of Europe Steam Navigation Company was mentioned. The *City of Norwich*, 183 feet long, 26 feet beam, 471 tons burthen, and 200-horse power, could carry as cargo 220 head of cattle, at a speed of 10 knots per hour, but she rolled considerably with a beam sea; whilst the *Tonning*, 222 feet long, 27 feet beam, 734 tons burthen, and 200-horse power, carried 360 head of cattle, at a speed of 12 knots per hour; she was a remarkably easy vessel, and had proved her seaworthy qualities by coming safely round the coast of Scotland, during the late gale in September. Thus, with the same engine-power, by merely altering the proportions from 7 to 1 to 8 to 1, nearly 60 per cent. more cargo space was obtained, and 2 knots per hour were gained in speed, with improved sea-going qualities. It must be remarked, also, that the relative proportions of the *Tonning* were almost identical with those of the proposed iron vessel for the Eastern Steam Navigation Company.

Taking the *Wave Queen* as an extreme case—her length being 213 feet, with 15 feet beam, and proportions of 13 to 1, with a draught of water of only 5 feet, and comparing her performances with those of the *Christiania*, a good vessel, about 170 feet long, and with about the proportion of 6 to 1—it was found that whilst the latter in a moderate head-sea continually shipped the waves, the former in a similar sea was perfectly dry. This evidence was given from the personal experience of the speaker. The *Wave Queen* had since been running between Newhaven and Dieppe, and it was to be expected, indeed it had been predicted, that from local circumstances connected with the entrance of the harbour at Newhaven, she would meet with some casualty. She was not stranded in consequence of any inefficiency in the power of the rudder, but after a very bad passage across the channel in the trough of the sea, which was running very high, she arrived off Newhaven when there was scarcely depth of water over the bar for her to cross, she touched the ground heavily, and hung by her 'heel;' a beam sea catching her at the same moment, swung her round and threw her broadside on the beach, where all the passengers were safely landed. It was a good proof of the strength that could be given to iron ships, that though she was thrown broadside on the shore by the waves of translation, she was safely got off and brought round to the Thames without material damage.

As to the elaborate calculations entered into with respect to the three great navigation projects; before admitting the correctness of those results, it must be clearly understood that the *Rattler*, which had been used as the type, was built during the most depressed period (scientifically) of construction in H. M. Dockyard. Her dimensions were 176 feet long by 32 ft. 6 in. beam,—a proportion of about 5½ to 1, and from what had been published it must be evident that she had just performed what might have been anticipated from such proportions. At the time of the construction of the engines of the *Rattler*, marine engineers had scarcely adopted, and rarely practised, the use of the steam at a certain amount of pressure, and expanding in the cylinder, whereby such a vast economy in the consumption of fuel was now realised. Now, if the calculations of fuel required for long voyages were based upon the old scale of consumption, instead of the present rate, which in good ships did not exceed 3½ lb. per real horse-power, the deductions from the calculations must be still more unacceptable.

It was then contended, that all arguments based upon calculations of the speed and other qualities of such a type must be utterly fallacious. It had been shown what increase of speed and of carrying qualities had been produced by lengthening the *Tonning*, without increasing her power, and by analogy it was only reasonable to presume, that if the proportions of the *Rattler* had been altered from 5½ to 1, to nearly 8 to 1, there would have been a still more striking amelioration, and she would have been a more trustworthy type for the calculations and arguments as to the practicability of constructing and of commercially working large ships. It was argued, that with all these, and many other examples to the contrary, it was evidently incorrect to attempt to assume that 6 to 1 was the best proportion for vessels of any kind.

It was assumed, that when it was stated a large steamer was intended to run to India or Australia and back, without re-coaling, it was only meant that she would carry coal enough to avoid detention at the intermediate ports, as (unless it was ascertained that she could not procure a more profitable cargo) it would evidently be more economical to send coals to the ultimate and distant port by sailing vessels, who would convey them cheaper than she could do.

It must not be supposed that the meeting received for granted the results of calculations based on such a type as the *Rattler*, nor that the Institution could pretend to do more than offer a field for the investigation of the scientific portion of the magnificent commercial experiments about to be tried, and for the success of which all must unite in offering their best wishes. Engineers, unless especially called upon to give opinions on the prospects of commercial success offered by undertakings, were only expected to consider the best means of executing given works at the cheapest rates, compatible with security and durability, but the ultimate remuneration for the outlay must be mainly a subject for the consideration of the speculators.

The advantages of employing a smaller number of large ships rather than a greater number of small ships, for a given trade, especially for long voyages, was beginning to be generally admitted by shipowners. A return was published in the *Times* of Nov. 22nd, 1853, copied from the *Liverpool Albion* of Nov. 21st, which presented the results of that experience in a remarkable form:—

"The following Table shows the average number of days occupied on the passage by the vessels of different tonnage, ranging from 200 tons upwards, dispatched from Liverpool to Australia in the years 1852 and 1853:—

| | Average number of days in 1852. | Average number of days in 1853. |
|---|---|---|
| Under 200 tons | 137 | 133 |
| From 200 to 300 tons | 122 | 122 |
| „ 300 to 400 „ | 123 | 113 |
| „ 400 to 500 „ | 118 | 112 |
| „ 500 to 600 „ | 113 | 112 |
| „ 600 to 700 „ | 107 | 103 |
| „ 700 to 800 „ | 108 | 101 |
| „ 800 to 900 „ | 103 | 100 |
| „ 900 to 1000 „ | 102 | 95 |
| „ 1000 to 1200 „ | 96 | 91 |
| „ 1200 and upwards | 91 | 90 |

From the above table it will be seen, that in almost every instance the average is in favour of the largest ships, the 600-ton ships having an advantage of 24 days, on the average in 1852, over the 200-ton ships, and the 1200-ton ships having an advantage of 22 days over the 600-ton ships. In 1853, also, it will be seen that the results are much the same."

But even with this evidence, it would not be wise to rush to the conconclusion, that vessels of enormous size would be applicable in all circumstances; in fact, that which determined the expediency of using a large ship was the coincidence of a great amount of traffic and great length of voyage. For example, it might be questioned, except for some special branches of commerce, which appeared now about to be greatly developed, whether a very large ship would be likely to be commercially beneficial, between any two ports of Great Britain. It must be evident, that for each length of voyage and description of trade there was a particular size of vessel that would be most suitable; and, indeed, as in most other engineering works, the circumstances of the traffic would of themselves mainly determine the proportions of the structure; take, for example, the trade between England and America, as originally opened by the *Great Western*; that vessel, as first designed, although much the largest ship of her day, was of the smallest size by which such a trade could be conducted; and her length was actually increased, during her construction, to a point then generally considered dangerous.

Since that period, all vessels on that station had been successively augmented in dimensions as the trade increased; but even those vessels were too small for the Australian voyage of 25,000 miles, and the necessity of increasing the length was shown, by calculating how much coal would require to be carried, beyond that needed for an American voyage, in order to do the Australian or the Indian voyage equally well. Such calculation demonstrated that a vessel similar to the *Great Western* would require to be lengthened to 520 feet to accomplish that voyage. This argument showed that the conditions of the case compelled the adoption of vessels of extraordinary length for steam voyages of extraordinary distance.

Then, as to the commercial question: the merchants engaged in the Indian and Australian trade had calculated, from the data afforded by their own business, what amount of freight and passengers would require accommodation, and it was found that the quantity was greater than could be received by the ship just calculated. The dimensions, therefore required to be enlarged to meet the demand of the existing trade. Thus the traffic itself did actually fix the dimensions of the proposed large class of vessels.

As to the mechanical strength of such vessels, there was no difference of opinion on that point among engineers, provided the structure was of iron. Ships of wood, on the contrary, were limited in size by the nature of the material, which was *grown*, and not *manufactured*, and therefore the produce was of limited size; whereas plates of iron could, on the other hand, be rolled of any required dimensions. It must be observed, also, that the strength of wood across the fibre was so small that two planks could not be so united as to be equally strong in all directions, whilst two plates of iron riveted together were of nearly uniform strength.

Further,, as to the resistance of large vessels to waves: it was evident that the waves of the Atlantic, being of the same size, whether the vessel was small or large, their proportional magnitude would be decreased as the size of the vessel was increased, so that the large ship in a gale would merely encounter waves of the same proportional size as a ship of half the dimensions in half a gale; and it should be remarked that the largest ships which had been proposed were only double the lineal dimensions of existing vessels.

As to the impact of waves upon ships, it should be remembered that a vessel riding on a wave became, virtually, a part of that wave, and moved along with it, as the mass of water displaced by its bulk had previously moved. The large Atlantic waves, observed by Dr. Scoresby, did not strike the ship, but made her rise and fall in a gentle oscillation, each of which lasted sixteen seconds, a period of too long duration to admit of any approximation to violent collisions between bodies. It was only the small wind waves or crests which moved at a different velocity from that of the ship, and the proposed vessels were so much higher out of the water than the observed altitude of these waves, that the decks would probably never be more than wetted by the spray.

It was explained that H. M. S. *Rattler* had been assumed as a type of locomotive efficiency, because the formula $\left(\frac{V\ \sqrt{}^{3}\ D^{\frac{2}{3}}}{\text{Indicated H. P.}}\right)$ gave the highest result of any steamer examined by that rule. It would be seen that the formula merely embraced the relations of velocity, displacement, and working power.

It was stated, that a vessel which from any fault of construction, or from imperfect steering power, was liable to fall off into the trough of the sea, would in that position be liable to fearful accidents; and instances were cited of two vessels, of 800 tons and 1200 tons respectively, being struck by waves which had carried away all the upper works and swept the decks clear. These practical facts were given to show that the gentle oscillation of heavy waves must be received with some qualification. In answer to this, it was explained that in a storm there were generally two sets of waves, the long low oscillating wave, and the smaller waves, which were much shorter, rising under the action of the wind. It was those short waves which struck the smaller vessel with so much force when they got on the crest of a large one, but the deck of a very large ship would be too high for such wind waves to break upon it except as spray.

Returns were presented of the performances of a number of paddle-wheel ocean steamers, for a period of twenty-two years, tending to prove how greatly the velocity has been increased. This was shown to have arisen from the augmented size and better build of the vessels, with greater power of engines and other engineering improvements. These tables showed the necessity of a careful selection of the period, from which a mean average of velocity was deduced; for example, the *Hugh Lindsay*, H. E. I. Co.'s steamer, gave in 1830 a mean average of 5¼ knots per hour; whereas the best of the Cunard and of the Collins' lines of steamers gave a mean average of 12¼ knots per hour for the last three years.

It was explained, that the average of 7$\frac{6}{10}$ knots per hour had been derived from Admiralty returns, extending from 1848 to 1851,—which were the only reliable documents of the kind hitherto published. Members were urged to supply the present evident want of information on this subject.

As to the question of measurement for tonnage, after discussing the present method, describing that proposed by the Parliamentary Committee and those by the practical men who had been consulted, the system indicated by the author of the paper was examined with care, and was admitted to possess novel features worthy of consideration in fixing a legal standard of measurement. It was, however contended, that for scientific purposes, the displacement to the load-line was required, and for fiscal purposes it was submitted, that the light and other dues would be more equitably imposed by an *ad valorem* duty on the cargo, rather than on the bulk or form of the vessel.

In winding up the discussion, the dimensions were given of a great raft ship called the *Baron of Renfrew*, which was built in Quebec in the year 1825, by the late Mr. Charles Wood, of Port Glasgow. Her extreme length was 304 feet; extreme breadth, 61 feet; clear depth, 34 feet; registered tonnage, 5294½ tons; and cargo of timber 8500 tons. The draught of water at the end of the voyage, when waterlogged, was 31 feet. She had four masts and the sails of a 36-gun frigate. Her greatest inclination under press of sail was about 20 degrees. Her greatest speed before she became waterlogged, but with 19 feet of water in the hold, was 8½ knots, which was reduced to 6 knots when she was quite full of water. She made the passage from Quebec to the Isle of Wight in forty-eight days. It was due to Mr. Charles Wood to mention this daring innovation at so early a period.

It appeared, that if the dimensions of vessels had been increased, it was evident that there had not been any increase of danger, nor was any to be anticipated. The hesitation in receiving new propositions of startling projects was very natural, and therefore their discussion was valuable and really useful in eliciting opinions which might otherwise probably not have been given. The feasibility of the Britannia Bridge had been quite as much doubted as that of very large iron ships, and yet it had been executed, and the result was before the world. It appeared evident, that in future engineers must look even further forward than they had done, and in their maritime constructions must adopt dimensions for their docks and harbours to accommodate the increased sizes of the vessels they were destined to receive, but which some years since would have been deemed visionary.

*December* 6.—The paper read was, "*On the Drainage of the District, South of the Thames.*" By J. T. Harrison, M. Inst. C.E.

The district south of the Thames, comprised in the "Surrey and Kent division of the sewerage of the Metropolis," was briefly described as extending between Battersea and Greenwich, over an area of upwards of 9 miles in length, with widths varying from ¼ mile to 2¼ miles, bounded by the river Thames on the north, east, and west sides, and by the rising ground on the south. Its chief peculiarities were that the surface was almost entirely below the level of high water mark,—that it was, to a considerable extent formed of alluvial deposit, permeable to and surcharged with water, and it was moreover subject to frequent flooding from the adjoining high land. For such a district the points demanding attention were shown to be;—thorough drainage of the land,—means of preventing the inflow of water from the neighboring high land,—the rapid discharge of the rain-water falling on the area,—and the regular conveyance away of the sewage matter, not only from the houses but from the main sewers.

The present system of drainage was shown to be very defective, but the author expressed his conviction of the possibility of remedying the existing defects, and of taking advantage of the assistance of the rise and fall of the tide, and of other local circumstances, for thoroughly effecting both the cleansing of the sewers and the drainage of the district, by means inexpensive in themselves and independent of the casualties of steam pumping machinery or of the caprice of ratepayers.

It was shown, that the existing sewers acted partly as drains for the land water, but they only extended over a portion of the area, whilst from their being so frequently full, and even being under pressure, the sewage matter escaped from them and saturated the ground;—it was therefore contended, that a system similar to ordinary agricultural drainage should be carried out. The question was incidentally raised for discussion, whether advantage might not be taken of the known rapid filtration of the chalk formation, to facilitate this operation, by sinking several wells into which the land drains might converge. The interception of the upland water by catch-water drains was insisted on, and the necessity for it pointed out. The rain-water was proposed to be conveyed away by the existing sewers, which would require some addition.

The conveyance of the sewage matter from the houses of the district was next discussed. This was divided into two stages,—the first; from the houses to the public streets, and the second, from the streets to its destination. The means of obtaining the first point were simple, and the stoneware pipes were recommended as sufficiently good, if of large diameter, and laid properly on a system of separate rather than of combined drainage. For the second point, Greenwich marshes being fixed upon for the temporary reservoirs or recipients of the sewage matter, and the Thames as the ultimate distributor of it, it was proposed to take advantage of the fall of the Thames between Battersea and the Greenwich marshes, which was stated to be 3 feet at the lowest neaps, 5 ft. 6 in. as a mean, and 7 ft. 6 in. at the highest spring tides, and by a copious use of Thames water to flush out the main sewer daily. This could be accomplished by forming a main sewer 8 feet in diameter, from Battersea to Greenwich marsh, having the same fall as the Thames at low-water neap tides; its invert being one foot below low water, and having a communication with the Thames at each end, so that water from the river might flow through at low water; forming, also, reservoirs for arresting and collecting the sewage, and a canal for receiving the liquid after the filtration or precipitation of the solid matter. This canal, excavated 6 feet below low-water spring tides, extending across the marsh and being connected with the Thames at each end with proper gates, &c., so that water from the river might flow through it towards and at low-water, leaving it full of pure water when the gates were shut on the rising of the tide. The overflow from the reservoir into the canal might be 2 feet above the highest low-water mark, so as under the most unfavourable circumstances to give that depth for the filtered sewage water and that used for flushing, to accumulate during high-water. It was contended, that by having the mouths of all the cross sewers communicating with this main duct fitted with flaps, the head of water derived from the Thames, which would be 15 feet at springs, and 10 ft. 8 in. at neap tides, would give a velocity through the main sewer of about 2 ft. 6 in. and 2 feet per second respectively, which would be sufficient to clear away any deposit. This canal might also be used for loading barges to carry away the sewage, either for agricultural purposes or for discharging lower down the river or out at sea.

It was further proposed to form cross drains at convenient distances apart, from the Thames to the main sewer, which should be flushed by a head of water from the river at high water, all the collateral drains into these being fitted with flaps. These, it was contended, might be kept nearly level, the head of water being abundant for thoroughly flushing them. The collateral drains being constructed with a good fall and communicating at each end with the cross drains, could be thoroughly flushed at stated periods.

The question of the applicability of the existing sewers was then examined, and from data afforded by Captain Vetch's sections, it was considered that they might be made available; the large proportion of 41 miles of open ditches (in 1848) to 30 miles of closed sewers, was urged as a strong argument for the introduction of an entirely new system. It was urged, that the chief point to aim at was the adoption, if possible, of a system that would work well without any mechanical pumping, as steam power could be added if found necessary for discharging the sewage matter into the Thames at high-water.

Comparisons were drawn between Captain Vetch's plan, and that now proposed to be carried out by the Commissioners of Sewers. It was urged, that Captain Vetch's "long covered tank, reaching far into the district to be drained," retained some of the most objectionable features of the present system, and that the Comissioners' plan of flushing from the Thames, being dependant for its success on the steam-engine pumping out the water as fast as it was let in from the Thames, was undesirable, and liable to be entirely frustrated by accident.

An appendix contained some communications made by the author, in August 1849, to the Metropolitan Commissioners of Sewers, in answer to their appeal to the public for suggestions on the subject of the sewerage of London. In those documents, a system of drainage was proposed the chief point of which was the making use of the head of water afforded by the rise of the tide in the Thames, for a general system of flushing the whole of the sewers of the low-lying districts, and in many respects similar to the system described in the paper.

*December* 13.—The discussion was resumed on Mr. Harrison's paper, and was continued throughout the evening. The complete system of sewerage introduced at Hamburgh, since the great fire, by Mr. Lindley, C.E., was alluded to as a good instance of the efficiency of the plan of flushing sewers, even in very flat districts, and with syphon dips, when there existed a head of water like that from the Alster lake, which was 13 feet above the high-water mark of the Elbe.

The culvert through which the Frome passes beneath the float, and flows into the Bristol river, was also described, and from these and other examples of the advantages of flushing sewers, that system was urged to be preferable to the labour and expense of pumping up from depths below low-water mark, the ordinary sewage contents, without dealing with the rain-water falling during thunderstorms, which it was contended could not be raised by any amount of steam-power which could be practically adopted. In fact the employment of steam-power for pumping out the sewage was opposed on the grounds of the constant expense, and the liability to stoppage from accidental causes. It was also argued that the drainage of fen lands by steam-power was not analogous, as the fen water-courses were so large as to form reservoirs, whence the pumps lifted the water in a given, but lengthened period of time; and even then not so as to avoid such back flooding as could not be admitted for town drainage.

The best systems proposed were stated to be the interception of the highland waters, the carrying away by gravitation all the contents of the sewers which could be discharged into a low point of the Thames by natural means, and resorting to pumping only for such portions of the metropolis as were too low for any other system. Such, it was contended, was the plan which had been proposed by Mr. J. R. M'Lean, to the Commissioners of Sewers, in 1849; and in a review of the systems proposed by Captain Vetch, the late Mr. Forster, and Mr. Bazalgette, the accordance with and the deviations from the original plan were pointed out and commented on.

The necessity for providing against any chance of flooding the basements of the houses, by allowing the main sewers to become filled and be under pressure, was insisted on. Doubts were expressed as to the possibility of obtaining sufficient velocity to scour out such main sewers as those proposed to be flushed from the Thames, and having their outlet at Greenwich.

The question of pipe drains and brick sewers was again entered upon, and it appeared that experience confirmed the previous impressions of the applicability of the pipes to house drainage only when they had rapid fall and were of sufficient area, but that nothing could be relied upon for sewers except brick constructions, sufficiently large to permit access within them; they should also be permeable, so as to act as drains in conveying away the land water from the district which they traversed. It was stated, that in Lambeth there were spots which about 25 years since were full of water, but which at present during the summer were found to have been thoroughly dried by the action of the sewers passing through or near them.

It was urged, that the question of the proper outlet for the sewerage could only be fixed by careful investigation of the period during which the matter remained suspended, and the distances it travelled up and down the river with the ebbing and flowing tides; the experiments made on this point did not appear to be received as authority.

In treating the questions of detail, it was shown that the brick sewers never practically became elongated cesspools, as had been asserted; that there was really greater scouring power in an egg-shaped sewer than in a pipe drain; that the alleged smooth interior of the pipes was illusory, as their joints were more liable to occasion stoppages than the joints of the brickwork; that the interior of the latter did, practically, soon become covered with a slimy matter, which aided the flow; and that deposits rarely occurred, except where the sewers were too flat and too small.

As to the question of cost, it was shown that the statements of the comparative expense of the metropolitan and of the country drainage works, as published "by authority," must be received with caution; the cases were not analogous from the impossibility of comparing the ducts made to convey sewage one quarter of a mile, with those intended to convey the cumulative proceeds of many miles of dwellings. The mere difference of the cost of labour beeween London and the country would preclude comparison as to the expense of works; and the local difficulties of cutting underground in large cities must be taken into consideration.

*Dec.* 20.—Annual General Meeting.—The evening was devoted to receiving the Annual Report of the retiring Council, to the election of the President, Vice-President, and other Members of the Council for the ensuing year, and to the presentation of the Medals and Premiums which had been awarded.

The Report succinctly reviewed the progress of engineering works at home and abroad, and the general prospects of the profession, which appeared to be most satisfactory. It touched upon the successful results of the Industrial Exhibition at Dublin, due to the liberality of Mr. William Dargan, whose name was so intimately connected with engineering works.

The sanitary improvements and other branches of engineering, having for object the social advancement of the community, were commented on, and the great works, both of public utility and architectural embellishment, in progress in France, under the present energetic ruler of that kingdom, were pointed out as worthy of exciting our national emulation.

With so extensive a choice of subjects, the paucity of papers transmitted for the meetings was pointed out; and rather startling statements were given, showing how few of the members of all classes had fulfilled the obligations entered into on joining the Institution.

The principal papers read during the past session were enumerated, with a short notice of each, and the tenor of the discussions, which were shown to be the distinguishing features of the meetings of the Society. It was apparent that those were the most valuable papers which were the most readily furnished by engineers, as being observations of the effects of natural causes in constant operation, in the vicinity of work constructing under their direction, and the attention of members was urged to that point. It was gratifying also to observe, that premiums were awarded for four papers, contributed by gentlemen who were not connected with the Institution.

The following medals and premiums were presented:—Telford Medals to Messrs. Coode, Clark, Brooks, Huntington, Burt, Duncan, Siemens, Cheverton, and Barrett; and Council Premiums of Books to Messrs. Richardson, Armstrong, Rawlinson, and Sewell.

Attention was directed to the engraving of Mr. Andrews' portrait of the Past-President, Sir John Rennie; to the portrait of Brindley, presented by Mr. Hawkshaw, and to a marble bust of the first President (Telford), by Hollins, which had been lost sight of for many years, and only accidentally recovered by the Secretary within the last few months. It was now restored to the Institution, for which it had been originally destined, and Mr. Rendel, as a last act of Presidentship, presented for it a pedestal appropriately carved from a block of Peterhead granite—a material which had been so extensively employed in the works of the first President of the Institution.

The deceases noticed were few: they were Major-General W. G. MacNeill (U. S. Army); John Green and Tomaso Cini; Members:—Col. J. N. Colquhoun, R.A.; and Messrs. E. J. Dent and G. Bradshaw, Associates. The memoirs detailed the services of these two distinguished officers, who to their military tactics united great aptitude for engineering pursuits; the numerous works of an old member of the profession; the labours of a foreign coadjutor, too early removed from a sphere of usefulness; the ingenuity and excellence of workmanship of the well-known chronometer maker; and the kindly disposition, the watchfulness for opportunities of doing good, and the energy in pursuing his useful course, of him who was the pioneer in all guides for travelling the complicated network of railways in this country and on the continent.

The financial statement showed that though there was a heavy debt for printing, yet the annual income now, for the first time, exceeded the ordinary expenditure; it was deemed expedient to expunge from the accounts a large amount of arrears of subscriptions, and to erase the names of the defaulters from the register of the Institution.

It was shown that the cost of rebuilding the house of the Institution had been entirely defrayed from the Building Fund, by which also all repairs were now provided for; and that the past and present Members of Council had made voluntary contributions, in aid of the funds of the Society, to an amount far exceeding anything imagined by the general body of the members.

The vital importance of printing the arrears of the Minutes of Proceedings, and of giving rapid publicity to the papers and the abstracts of the discussions, was generally admitted; the question had occupied the serious attention of the Council, and nothing but the fear of involving the Institution in hopeless financial difficulties, had caused the present arrears of publication. After giving an account of the progress of the printing of the volumes of the Transactions and of the Minutes of the Proceedings, showing the gradual extension and the cost, it was demonstrated, that there existed no other bar to the rapidity of publication, than the extent to which the members of all classes were willing to assess themselves, by voluntary or compulsory contributions, to defray the inevitable amount of expenditure for printing.

This statement produced a lengthened discussion, which resulted in the determination that contributions should be collected from members of all classes, on the following scale:—President, thirty guineas,—Past Presidents, Vice-Presidents and Members and Associates of the Council, twenty guineas each,—Members, five guineas each, and Associates, one guinea each.—This assessment was cheerfully agreed to, and several Members and Associates present, doubled the amounts of their contribution, to aid in the very desirable object of immediate publication of the Minutes of Proceedings.

The thanks of the Institution were unanimously voted to the President, Vice-Presidents, and other Members and Associates of Council; also to the Auditors, the Scrutineers of the Ballot and to the Secretary for their services.

The following gentlemen were elected to fill the several offices in the Council for the ensuing year:—James Simpson, *President:* G. P. Bidder, J. K. Brunel, J. Locke, M.P., R. Stephenson, M.P., *Vice-Presidents:*—J. Cubitt, J. E. Errington, J. Fowler, C. H. Gregory, J. Hawkshaw, T. Hawksley, J. R. M'Clean, C. May, J. Penn, and J. S. Russell, *Members*; and H. A. Hunt and C. Geach, M.P., *Associates of Council.*

Mr. Rendel, President, on quitting the chair, which he had occupied for two years, with such advantage to the Institution, addressed the meeting; he alluded to the general professional employment in all parts of the world, and noticed with pride the preference exhibited for British engineers, whose scientific and practical skill was no less acknowledged than their known probity and honour. The importance attached to the title of Member of the Institution, was referred to, for the purpose of pointing out the necessity entailed by it for fostering and sustaining the reputation of the Society, and for making its archives the depository of the records of all the best engineering works. He pointed out also that all periods of agitation for change were dangerous epochs for societies, and more especially for the Institution of Civil Engineers, whose peculiar bond had hitherto been the merit of having closely united those members of the profession who formerly could rarely be brought together. All changes, then, should, he urged, be gradual, and above all result only from careful consideration by the older members, who on all occasions had demonstrated their anxiety to bring forward their juniors. He then thanked his coadjutors and the Secretary for their assistance; commended his successor to the same kind consideration as he had experienced, and with regret retired into the class of Past-Presidents, after being an active member of the Institution for thirty years, during thirteen of which he had been successively elected on the Council, and had now completed his second year of tenure of the office of President.

The meeting was then adjourned until Tuesday, January 10th, when the discussion will be resumed on J. T. Harrison's paper, "On the Drainage of the District South of the Thames," and if time will permit, the paper "On Incline Planes for Canals," by J. Leslie, M. Inst. C.E., will be read.

## RECENT AMERICAN PATENTS.

[Reported in the Journal of the Franklin Institute.]

*Oven Doors for Cooking Stoves and Ranges.* G. North.

*Claim.*—The application of an adhesive coat of enamel, or other substance answering the same purpose, to the inside of the oven doors of ranges or cooking stoves.

*Scythes.* W. P. Greenleaf.

*Claim.*—Widening and curving the blade of the scythe at the shank, for the purpose of strengthening the same, and adapting it to cutting bushes as well as grass.

*Facing Buildings.* M. B. Dyott.

The nature of the invention consists in an improved mode of uniting, fastening, and supporting cast-iron or other plates to the external walls of buildings, whereby the said plates form an ornamental facing thereto, are protected against external injury, and secured from the injurious and disfiguring effects of moisture from the interior.

*Boring Cannon.* L. A. B. Wallach.

The invention consists in producing a cylindrical hole in any solid substance suitable for making cannon or small arms, by boring out an annulus of the diameter of the required hole, leaving a central core two-thirds, more or less, of the diameter of the bore, which can be broken off when the annulus is completed, to the required depth, and removed in a solid mass, instead of being cut into fine chips or shavings, as in the ordinary way of boring, whereby much labour and time are saved, and the expense of boring is greatly reduced. The core likewise furnishes a sample or test of the nature or quality of the material in the interior of the substance being bored, and this method of sampling the material, which is highly important in the boring of cannon, constitutes another branch of the invention. The means of removing the core after the annulus is bored, also constitutes another branch of the invention. This mode of boring cannon differs from all others now practised or known—first, in leaving a solid core formed by the cutting of an annular space around it while the boring progresses, and which core is usually of greater bulk than half of the material to be removed; and secondly, in afterwards detaching this core as a solid, instead of reducing it to particles in the form of chips and dust; as in the usual mode of boring. The dead centre of the ordinary boring-tools, which is a great impediment to the progress of the work, is entirely avoided by this method of circumaxial boring, wherein no such centre exists. The centre of every common boring-bit forms its pivot or axis of revolution, and having little or no circumferential motion, cannot possibly cut out a chip. It can therefore only progress through the substance by the force of pressure or crushing alone. In this method the cutting edge is reduced in extent to at least one-third of that of any other boring tool, by which both time and expense are saved, in proportion to the diminished amount of material to be removed; and being placed at and near the periphery of a hollow cylinder, it works there with greater effect in the ratio of its greater distance from the axis, and by avoiding the dead centre of other modes of boring, effects a still further saving of time, in proportion to the greater facility of cutting over that of forcing or crushing a tool into the mass to be perforated.

*Claim.*—The method of boring cannon, or the barrels of other ordnance or fire-arms, by perforating the same with an annular hole, which leaves a central core, in combination with a second operation for detaching and removing the core, whereby the amount of material to be reduced to chips, the time and labour of boring, and the wear of tools are greatly diminished, and the accuracy of the work increased. Also the transverse cutter for grooving or cutting off the base of the core; and the method of ascertaining the quality of the gun by taking out a core of sufficient diameter and length from the axis or centre of the bore, to be tested mechanically.

*Turbines.* U. A. Boyden.

*Claims.*—1. The leaning or inclining of the leading curves or guides to the plane of the wheel. 2. The making of the inside of the garniture, or the part of the gate next the disc, or both, of such a curvature or form, that the water at the upper part of the stream or streams, where it leaves the garniture or gate, will have a downward motion, or a direction inclining to the plane of the water-wheel, and making the upper sides of the passages for the water through the wheel descending or inclining to the plane of the wheel, from the commencement of the passages next the gate to about half-way from the inner to the outer edge of the upper rim of the wheel, where they are nearly or quite horizontal, or nearly or quite parallel with the plane of the wheel; the inclination of that part of the lower surface of the upper rim of the wheel which is next the gate, being the same or nearly the same as that of the lower surface of the gate next said upper rim, and the change from inclining to horizontal being gradual, as by a curve; or making the upper surface of the disc, next the lower rim of the wheel, to incline up toward this rim, and making the lower sides of the parts of the passages through the wheel, which are next the disc, ascending or inclining to the plane of the wheel, so that the stream or streams will gradually diminish in height at the entrance or entrances into the wheel, so that the water which passes in the upper parts of the stream or streams will converge toward that which passes in the lower parts of the stream or streams, before striking the floats, and continuing this converging into the wheel to about one-half the distance from the inner to the outer edges of the rims of the wheels. 3. The forming of the lower part of the tube which sustains the disc, and the forming of the top of the disc on that part of it next the tube, and fastening these parts together. The inventor in his claims has written of the turbine as having its common position, in which case the water descends to pass between the leading curves, without alluding to its ever having any other position; but extends the claim to the cases in which the wheel is vertical or inclined to the horizon, and to the case when the water ascends to pass between the leading curves.

*Turbines.* U. A. Boyden.

*Claims.*—1. The arrangement of a gate at the entrance of the water into the wheel, with a part or all of the garniture or lining, and other parts of the turbine within, over, and about the gate, such that the gate and a part of the garniture, if any be attached to it, may move freely, while the part of the garniture not attached to the gate, and other parts over and about the gate, remain stationary, and so closely fitted that little or none of the water in the flume can run to the upper part of the gate, excepting by passing under the stationary garniture, and afterward upward, so as to diminish the liability of sediment, dirt, or other substances being carried by the water to the upper part of the gate, or moveable part of the garniture, if any be attached to the gate, so as to obstruct the motion of the gate, or moveable part of the garniture. 2. The leaning or inclining of the floats or buckets of turbines to the rims of the wheels, so that when the wheel of a turbine is working, with the gate next the wheel partially open, the parts of the floats opposite the aperture formed by such partial opening of the gate, will be forward of those parts next the other rim of the wheel, so that the leaning of the floats will diminish the spreading or deflecting of the streams into the part of the wheel opposite the gate. The claim extends to all degrees of inclinations, which will substantially answer the same purpose, as this effect of inclining the floats depends on the streams only partially filling the wheels. It does not extend to inclining the floats to any such turbine or hydraulic motor as has no gate at or near the water wheel, or other means of varying the width, thickness, or number of streams which enter the wheel. 3. The arrangement of the diaphragms or partitions in reacting wheels, and in the wheels of turbines, at different distances from the rims of the wheels, in the several spaces between the floats, to facilitate regulating the motions of the wheels, as the effect of these diaphragms depends on the streams only partially filling the wheels. The inventor does not extend the claim to this arrangement of the diaphragms to such motors as have no gate next or near the water wheels, or other means of varying the width, thickness, or number of streams which enter the wheels. 4. The combination of the device of making the gate at the entrance for the water into the wheel, to move separately from the garniture, with the leaning guides or leading curves, which direct the water into the wheel, so that when the gate is partially open, the part of the water which passes by or near the surface of the gate, in flowing toward this passage into the wheel, made by such partial opening of the gate, has its motion directed the way the wheel turns, in consequence of the leaning of the said guides. The claims extend to such turbines or hydraulic motors as discharge the water at their peripheries, and to such as have the water enter their wheels at their peripheries.

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*Hydraulic Motors.* U. A. Boyden.

*Claim.*—1. The arrangement of the gates around and next outside of the peripheries of the water wheels, between the wheels and the guides, or other things which cause the water to move obliquely toward the wheels in the way the wheels turn, when the water first strikes the floats or buckets. 2. The device to cause the height of the wheel, or the position of the parts which partially confine the water which presses the wheel upward, to vary as the height of the water or fall varies, so that the width of the aperture which lets the water escape from the place where it presses the wheel upward, varies proportionally to the quantities of water pressed into it; so that the force with which the water pressed the wheel upward will be nearly or quite constant, though the height of the fall varies greatly. 3. The combination of a gate around and near the periphery of a water wheel, between the wheels and the guides, or other things which direct the water the way the wheel turns into the wheel, with the parts of the floats near the gate curved, so that the water will strike their concave sides. The inventor does not limit his claim to an annular gate, between the wheel and the things which cause the water to move the way the wheel turns, before it enters the wheel, but extends it to all things which will substantially answer the purpose of a gate, in varying the height, thickness, width, or number of streams that enter the wheel. 4. The shape of the spaces between the rims of water wheels, which the floats are fastened to, in which they flare toward the axes of the wheels. The first, third, and fourth branches of the claim apply only to such hydraulic motors as have guides, or other things which cause the water to move obliquely toward the wheels, in the way in which the wheels turn, and pass into the wheels at their circumferential parts, and after acting on the floats, discharge from the floats inward. The inventor does not extend these divisions of his claim to the class of tub wheels and undershot wheels, in which the water generally flows into the wheels in streams, with spaces between the streams, at which spaces the water does not flow into the wheels. He does not limit either branch of his claim to cases in which the wheels are horizontal, or to cases in which the gates are opened by raising.

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*Gear of Variable Cut-off Valves for Steam-engines.* M. W. Baldwin.

The principle of varying the cut-off by means of a vibrating arm and sliding pivot block has long been known, but the contrivances for changing the position of the block upon the arm have been very defective. The radius of motion of the link by which the sliding block is changed on the arm, the radius of motion of that part of the vibrating arm on which the block is placed, have in this kind of valve gear, as heretofore constructed, been different, which produced a continual rubbing of the sliding block upon the arm while the arm is vibrating, and as the block for the greater part of the time occupies one position on the arm, and only has to be moved towards either extreme occasionally, that part of the arm on which the block is most used soon becomes so worn that the block is loose, and jars. This can only be remedied by dressing up the arm throughout its entire length; for if the brasses of the block were set up so as to make the block fit on the narrow portion of the arm, it could not be moved towards the extremes. To remedy these defects in the link motion, has long been a desideratum. The plan, however, of most engines now built, does not admit of the position of the parts of the old motion being so disposed as to avoid the difficulties specified, while this improvement can with the greatest facility be applied to any of them. This contrivance the inventor has essayed, and he states that it works well in practice, overcoming all the difficulties incident to the use of the numerous other gearing for variable cut-off valves.

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*Safety Valves.* Z. H. Mann.

The invention has for its object an increase of sensibility of the safety-valve, so as to ensure its opening at the desired maximum of pressure, and also so as to increase the size of opening in proportion to the force of steam, and thus ensure promptness of action and an adequate vent for the steam under all circumstances, thereby removing all danger or possibility of explosion with a suitable boiler. A flutter wheel, governor, and supplementary lever, or equivalent devices, is constructed, and applied to a safety-valve.

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*Working the Valves of Steam-engines.* R. H. Townsend.

*Claims.*—1. The combination of a cam and eccentric by means of the sector, or its equivalent, to operate on the valve or parts that move the same, and cut off or work with the full pressure by the eccentric, according to the position of said sector. 2. Adjusting the position of the sector by means of the governor, through the screw or other suitable means, whereby the governor regulates the position of the sector, to communicate the desired motion to the valve of the engine from the eccentric or cam, or both, according to the power required from the engine, as specified. 3. The rod and points to take motion from the block at its extremes of motion, and communicate the same by means of the right angle lever to the throttle or stop-valves as specified.

The invention consists in a peculiar combination of the eccentric and cam, the eccentric working as usual when operating on the valve to give the engine steam nearly the entire stroke; the cam so shaped that when it is brought into operation, the valve is moved in such a way as to cut off at the smallest part of the stroke at which the engine is required to work. These motions are combined by means of a sector operated on by the governor, that when the governor balls fall in consequence of the increased power required from the engine diminishing the speed, the eccentric is brought into operation on the valve; and when the engine is doing little work, the operation of the governor by sliding the sector brings the cam into operation, to cut off, and allow the engine but little steam; the regulation of the position of the sector by the governor thus at any intermediate point or at the extremes, supplying steam and causing the valve to cut off, in proportion to the work to be performed; and by a peculiar apparatus, in case the valve does not supply the required steam to keep up the momentum, the throttle valve is opened farther, or the reverse operation is performed if the work be thrown off the engine so as to need little steam.

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*Fences for situations exposed to Floods.* H. S. Ross.

*Claim.*—Zigzag and interlocked arrangement of panels, supported by a swivel joint to posts at suitable intervals, and having the joint between the two middle panels furnished with inclined hook and eye, each of said middle panels being provided with boards sloping in opposite directions, so that by the action of a flood, each half of the intervening line of panels may separate midway, and giving in the direction of the current.

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*Oskrigg Church, York.*—This church having become in a dangerous state, and unfit for the performance of divine service, it has been determined to partially rebuild it, and effect several other restorations. A committee has been formed to carry out the intended works, which will consist of the rebuilding of the nave and north aisle walls, new-north windows and east window of five lights. The nave roof of massive oak, a good specimen of the molded flat roof of the 15th century, will be replaced if decay, which has set in, be not too far spread. The whole of the present seating and galleries will be removed, and the church reseated with low open seats of an appropriate character, of memel wood stained. The stalls at the east-end, pulpit, reading desk, and communion table will be of English oak. This church not having a clearly-defined chancel, the eastern portion of the nave will be divided from the aisles by open screen-work of oak, and which, from portions of screen-work being found in the church, gives authority to this having been the original arrangement, the space behind being used as chapels. The general character fo the new work will be of the Perpendicular style. The present contract has been let to Mr. John Holmes, of Bramham; the architect is Mr. Thomas Dickons, of Durham.

## NEW PATENTS.

### PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAW AMENDMENT ACT.

*Dated Aug.* 9, 1853.—1853. H. des Moutis, Paris—An improved system of publicity.

*Dated Oct.* 5, 1853.—2272. A. Turiff, Paisley, Renfrew, engineer—Improvements in retarding apparatus for the prevention of accidents on railways.

2278. H. Stevens, Trafalgar-square, gentleman—Improvements in the preparation of vegetable substances for the purpose of preserving the same. (A communication.)

*Dated Oct* 11, 1853.—2328. J. C. Sharp, Paisley, Renfrew, engineer—Improvements in retarding apparatus for the prevention of accidents on railways.

*Dated Oct.* 12, 1853.—2344.—Robert William Waithman, Bentham House, York, gentleman—Improvements in apparatus for applying paint, varnish, and other liquid substances, and also for cleaning carriages, ships, roadways, houses, and other buildings.

*Dated Oct.* 14, 1853.—2364. William Jones, Porchester-street, Hyde-park-square, gentleman—A certain chemical compound or compounds applicable as a remedy for cuts, scalds, burns, wounds, and accidents of a similar nature to which the same can or may be applied.

*Dated Oct.* 19, 1853.—2407. P. A. L. de Fontainemoreau, South-street, Finsbury,—An improved composition to be applied in substitution of bone and horn. (A communication.)

*Oct* 20, 1853.—2428. J. Woofenden, Belfast, engineer—Improvements in power-looms for weaving.

*Dated Oct.* 21, 1853.—2432. J. G. Marshall, flax spinner, and P. Fairbairn, machinist, Leeds—Improvements in machinery for combing flax, tow, wool, and other fibrous substances.

*Dated Oct.* 24, 1853.—2454. C. F. Blunt, Montague-place, Russell-square,—An improved artificial fossil coal-fuel, which he desires to denominate "Blunt's diamond coal-fuel."

*Dated Oct.* 27, 1853.—2490. W. McNaughten, Manchester—Improvements in printing yarns or worsteds for weaving carpets, also in printing carpets, woollen, silk, cotton, and other textile and felted fabrics and fibrous substances.

*Dated Oct.* 28, 1853.—2499. W. Thompson, Clayton-street, Lambeth, gentleman—Instantaneously extinguishing conflagrations in ships' holds, warehouses, and other buildings.

*Dated Nov.* 1, 1853.—2520. J. Bottomley, Bradford, manufacturer—Improvements in ornamenting textile fabrics.

*Nov.* 1, 1853.—2532. T. S. Bale, Cauldon-place, Stafford, china manufacturer, and D. Lucas, Stoke-upon-Trent, artist—Improvements in ornamenting the materials of and articles manufactured in pottery, as bricks, tiles, slabs, &c., and also in glass, slate, stone, and other plastic substances.

*Nov* 2, 1853.—2542. B. Butterworth, Calder Cottage, Caldershaw, grocer—Improvements in combining oil with other liquids, for the obtainment of a new lubricating compound. (Partly a communication.)

*Nov.* 3, 1853.—2554. P. Hindle, Ramsbottom, manufacturer—Improvements in power-looms for weaving.

*Nov.* 4, 1853.—2556. James Scott, Shrewsbury—Improved apparatus for shifting carriages, wagons, engines, and other vehicles on railways and tramways.

*Dated Nov.* 5, 1853.—2570. J. B. Nicklin, Bartholomew-lane and Richmond, merchant—Improved gelatinous or glutinous compounds for lubricating railway and other machinery.

*Dated Nov.* 10, 1853.—2601. J. Atkins, Birmingham, writing-clerk—An improvement or improvement in ash-pits for grates.

*Dated Nov.* 10, 1853.—2602. W. Pidding, Tachbrook-street, Pimlico, gentlemen—Improvements in the manufacture of fabrics made of silk, cotton, wool, flax, hemp, straw, grasses, fibres, mohair, and other hair, spun glass, and enamelled, glazed, or plain wire, and in the application of some of those materials, and also in the machinery or apparatus connected with such manufacture.

2603. W. Rodger, Lieutenant in the Royal Navy, Shawfield-street, King's-road, Chelsea—Improvements in anchors.

2604. J. Stevens, Darlington Works, Southwark-bridge-road—Improvements in the steps or bearings of the axles or shafts of gasmeters.

2605. S. M. Folsom, Massachusetts, United States of America—A new and improved instrument for ironing clothes or various other articles. (A communication from J. W. Brown, United States of America.)

2606. P. A. Lecomte de Fontainemoreau, South-street, Finsbury, London, and Rue de l'Echiquier, Paris—Improvements in preventing accidents on railways, also in shifting and lifting railway carriages. (A communication.)

*Dated Nov.* 11, 1853.—2607. W. Parker, Birmingham, wire-worker—An improvement or improvements in bearings for machinery.

2608. S. Sturm, Carpenter's-buildings, London, and Vienna, optician—Machinery for the manufacture of optical lenses.

2609. A. A. V. S. de Montferrier, Paris, and South-street, Finsbury, gentleman—A new rotatory steam engine.

2610. E. G. Banner, Cranham-hall, Essex, gentleman—Improvements in saddlery and harness.

2611. H. Walker, Gresham-street West, London, manufacture—Improvement in means of communication from one part of a railway train to another.

2612. J. Willis, Wallingford, harness maker—Improvement in buckles.

2613. R. Dryburgh, Leith, cooper—Improvements in the means of holding staves while being cut.

2614. W. Steel, Glasgow, brewer—Improvements in machinery or apparatus for mashing malt.

2615. J. Platt, Oldham, machinist—Certain improvements in apparatus or machines for forging drawing, moulding, or forming spindles, rollers, bolts, and various other articles in metal.

2616. H. Kilshaw, Birch, near Middleton, manager, and Richard Hacking, Bury, machinist—Certain improvements in machinery or apparatus for spinning cotton and other fibrous substances.

*Dated Nov* 11, 1853.—2617. A. Easton, Barnard's-inn, gentleman—An improved lamp.

2618. A. Easton, Barnard's-inn, gentleman—A liquid chemical compound for the production of artificial light.

2619. J. H. Dickson, Evelyn-street, Lower-road, Deptford, flax manufacturer and flax machinist—Improvements in the process of preparing flax or similar fibrous materials, and rendering it fit for spinning and weaving.

2621. J. M. Levien, Davies-street, Grosvenor-square, upholsterer—An improved construction of expanding table. (A communication.)

*Nov.* 12, 1853.—2622. S. Barker, Birmingham, manufacturer—Improvement or improvements in shaping metals.

*Dated Nov.* 12, 1853.—2623. F. A. Delande, Paris, and of South-street, Finsbury, gentleman—A new metallic composition.

2624. H. Kilshaw, Birch, near Middleton, manager and R. Hacking, Bury, machinist—Improvements in machinery or apparatus to be employed in the preparation of cotton and other fibrous substances for spinning.

2625. J. Gedge, Wellington-street, Strand—Improvements in the means of consuming or otherwise preventing the escape of smoke from flues or other smoke-vents. (A communication.)

2626. J. Gedge, Wellington-street, Strand—Improvements in the manufacture of metallic compounds. (A communication.)

2627. W. Austin, Holywell-street, Westminster—Improvements in the manufacture of casks.

2628. T. De la Rue, Bunhill-row—An improvement in the manufacture of paper.

2629. W. Austin, Holywell-street, Westminster—Improvements in apparatus in trapping passages into sewers or drains.

2630. C. Busson, manufacturer, Paris—Improvements in finger-key musical instruments. (A communication.)

*Dated Nov.* 14, 1853.—2631. J. S. C. Hill, gentleman and E. Cottrill, Birmingham, manufacturer—Improvement or improvements in stamps and presses, a part or parts of which improvements may be applied to other purposes.

*Nov.* 14, 1853.—2632. W. Hadfield, Manchester, spinner and manufacturer—Improvements in looms for weaving.

2633. S. F. Cottam, Manchester, engineer—Improvements in machinery for spinning, doubling, and reeling cotton and other fibrous substances.

2634. H. Willis, Manchester-street, organ-builder—Improvements in the construction of organs and free-reed instruments.

2635. A. Cunninghame, Glasgow, iron-master—Improvements in the manufacture or production of sulphuric acid.

2636. M. Gray, Glasgow, engineer—Improvements in weft forks for power looms.

2737. A. P. Coubrough, Blanefield, calico printer—Improvements in bleaching apparatus.

2639. W. Smith, Mauchline, gentleman—Improvements in ruling ornamental figures.

2640. M. Fitzgerald, Sorrel Island, Clare, Esq.—An improved means or method of communicating between different parts of a railway train.

2641. Charles De Bergue, Dowgate-hill, engineer—An improvement or improvements in machinery or apparatus for removing patterns from moulds for castings.

*Dated Nov.* 15, 1853.—2642. J. J. Catterson, Islington, civil engineer—Improvements in carriage springs.

2643. C. E. Blank, Trump-street, merchant—Improvements in winding yarn into hanks. (A communication.)

2644. J. Liddell, Glasgow, merchant—Improvement or improvements in power-loom weaving.

2645. J. Cameron and J. Napier, Loughor, practical chemists—Improvements in obtaining gold and silver from ores, alloys, or compounds containing such metals.

2646. J. H. B. Thwaites, dentist, and W. B. Herapath, Bristol, M.D.—Improvements in the manufacture of quinine and other alkaloids.

2647. A. Delcambre, Paris—Improvements in machinery for distributing type.

*Nov.* 15, 1853.—2648. J. Fry, Cannon-street West, merchant—Improvements in preparing solvents for india-rubber and gutta-percha, and in rendering waterproof fabrics free from odour.

*Dated Nov.* 16, 1853.—2649. P. A. Halkett, the Albany, Lieut. R. N.—Improvements in apparatus for lifting and lowering ships and other heavy bodies, either submerged or otherwise.

*Nov.* 16, 1853.—2650. J. Ellerthorpe, Kingston-on-Hull, master mariner—Retarding and stopping railway trains and railway carriages.

2651. J. W. Wayte, Gate-street, Lincoln's-inn-fields, engineer—Improvements in self-feeding furnaces.

2652. J. R. Musgrave, R. Musgrave, and J. Musgrave, Belfast—Improvements in hot-air stoves.

2653. P. Hill, Gravel House, Coggleshall—Improvements in weaving plush and other piled fabrics. (Partly a communication.)

2654. J. Ronald, Paisley, manufacturer—Improvements in fixing colours on yarns and cloths.

2655. J. H. Johnson, Lincoln's-inn-fields, gentleman—Improvements in thrashing-machines, and in apparatus connected therewith. (A communication from Mons. Lotz, Nantes, machine maker.)

2656. D. Pratt, Birmingham—Certain mechanical arrangements for raising thimbles, the same to be worked by steam, water, or other power, thereby superseding hand labour.

2657. J. Ferguson, Heathfield, brick and pottery manufacturer—Improvements in furnaces and fireplaces, and in the prevention of smoke.

2658. W. F. Greenfield, Ipswich, clerk, master of arts—Improvements in communicating from one part of a railway train to another.

2659. T. Jackson, Commercial-road, Pimlico, contractor—Improvements in the manufacture of hats.

2660. J. Bristow, Bouverie-street, miller, and H. Attwood, Holland-street, Blackfriars-road, engineer—An improved mode of constructing marine boilers.

*Dated Nov.* 17, 1853.—2661. G. Carter, Mottingham, gentleman—Improvements in the construction of steam-engine boiler, and other furnaces.

*Nov.* 17, 1853.—2662. J. Clare, jun. Exchange-buildings, Liverpool, produce-broker—Improvements in the manufacture of bar and sheet metals, in machinery connected therewith, and in the application of such metals to various useful purposes.

2663. G. Dugmore and G. H. Millward, Birmingham, manufacturers—A new or improved method of signalling or communicating between trains on railways.

2664. S. Abraham, and S. V. Abraham, Lisle-street—Communicating information or directions to persons in charge of railway trains.

2665. W. Ashton, Manchester, machinist—Improvements in machinery or apparatus for manufacturing braid.

2666. J. Banfield, Birmingham,—Double-acting railway signal for preventing collisions or accidents on railways.

*Dated Nov.* 17, 1853.—2668. C. Burton, New Oxford-street, carriage manufacturer—Certain improvements in hand and draught carriages for common roads.

2669. T. Bourne, West Smithfield, saddler—Improvements in the construction of buckles.

2670. A. J. Hoffstaedt, Albion-place, agent—An improved mode of preparing the colour known as artificial ultramarine.

2671. R. Griffiths, Strand—Improvements in propelling vessels.

*Dated Nov.* 18, 1853.—2672. P. F. Keogh and W. A. Wilson, Liverpool, engineers—Improvement in steam-engines.

2673. P. M. Parsons, Duke-street, Adelphi, civil engineer—Improvements in railway and other carriages and vehicles.

2674.—A. Guy, Upper Rosomon-street, Clerkenwell, iron worker—A portable water-closet, with water supply without the action of pump.

2675. C. Fernihough and J. Fernihough, of the firm of J. Fernihough and Sons, Victoria Iron Works, Dukinfield, boiler makers—Improvements in machinery or apparatus for wringing or twisting, glossing, stretching, and drying silk, cotton, wool, flax, and other fibrous materials.

2676. T. Holmes, Pendleton, bleacher—Improvements in ventilating drying stoves.

2677. J. Gall, jun., Edinburgh, sculptor—Improvements in electro-magnetic engines.

2678. Amedee François Remond, Birmingham, gentleman—Improvement or improvements in the construction of steam-boilers or generators.

2679. W. Taylor, Park-street, Regent's-park—Improvements in anchors.

2680. J. Melville, Roebank Works, Lochwinnoch, calico printer—Improvements in printing textile fabrics and other surfaces.

2681. Jean Baptiste Clavières, Paris, engineer—Improved mode of giving publicity.

2682. M. Poole, Avenue-road, Regent's-park—Improvements in surface-condensors, and in evaporators and heaters for steam-engines. (A communication.)

2683. P. B. O'Neill, Paris—Improvement in the manufacture of perforated buttons. (A communication.)

2684. J. H. Brown, Arthur's-seat, Aberdeen—Improvements in the manufacture of artificial skins.

2685. H. R. Cottam, Sussex-terrace, Hyde-park-gardens—Improvements in the construction of portable houses.
2686. J. Rice, Foley-place, surgeon, and W. Matthews, Portugal-street, surgical instrument maker—Improvements in instruments for taking and applying vaccine matter.
2687. R. S. Norris, Warrington, railway engineer, and E. Talbott, Crewe, manager of ironworks—Improvement or improvements in the manufacture of iron.
*Dated Nov* 19, 1853.—2688. J. Harris, Hanwell, engineer—Improvements in apparatus for heating water and other fluids.
2690. M. Poole, Avenue-road, Regent's-park—Improvements in breech-loading fire-arms, and in cartridges for use with such fire-arms. (A communication from W. W. Marston, New York.)
2691. W. Austin, Holywell-street, Westminster—Improvements in the manufacture of tiles and tubes.
2692. E. Rowland, Mossley, near Belfast—Improvements in apparatus to be applied to a railway truck or carriage, to enable a guard or person to sound a whistle, and when necessary to put such truck or carriage in motion, independent of the locomotive engine.
2693. T. I. Dimsdale, Dublin, gentleman—The use and preparation of certain solid and liquid substances for the defecation, purification, and decolorisation of saccharine juices, and syrups or solutions, and for neutralising, decomposing, and absorbing noxious and fetid gases.
2694. J. G. Potter, carpet manufacturer, and R. Mills, designer, Darwen, Lancaster—Improvements in the manufacture of carpets.
2695. E. Wharton, Birmingham, engineer—Improvements in the manufacture of railway wheels.
2696. H. Daniell, St. Austell, Cornwall—Improvements in apparatus for drying clay.
2697. R. F. Brand, South-terrace, Bermondsey — Improvements in fire-arms and ordnance.
*Dated Nov.* 21, 1853.—2698. W. H. Tucker and W. R. Reeves, Tiverton—Improvements in locks.
2699. J. Scott, jun., Greenock, Renfrew, engineer—Improvements in steering vessels.
2700. H. Wiglesworth, Newbury, bachelor of medicine—Improvements in istons.
2702. Sir J. S. Lillie, South-street, Finsbury—Improvements in apparatus for the production of carburetted hydrogen gas. (A communication.)
2703. R. J. Sibbald, Paddington, Lancaster, surgeon—Improved mode of communicating from vessels to the shore, or from one vessel to another.
2704. A. Radcliffe, Chichester-place, King's-cross, glaziers' diamond manufacturer—Improved construction of glaziers' diamond.
2705. J. Cashmore, Bevis-marks, City, watchmaker—Improved mode of communicating signals on railways.
*Dated Nov.* 22, 1853.—2708. W. Greaves, Leeds, chemist—An indicator alarum, applicable to railways and railway trains.
2709. A. Bain, Paddington, engineer—Improvements in cases for holding cards.
2711. A. Bird, Birmingham, chemist—Improvements in apparatus to be employed for the purpose of communicating signals on railway trains and railways, which improvements are also applicable to other similar purposes.
2713. F. Meyer, Paradise-street, Lambeth—Improvements in treating fatty and oily matters to render them applicable for the manufacture of candles and night-lights.
2714. F. Levick, iron master, and J. Fieldhouse, Cwm Celyn and Blaina Iron Works, engineer—Improvements in machinery for raising coal and minerals from collieries and mines.
2715. F. Meyer, Paradise-street, Lambeth—Improvements in bleaching oils and fats.
2716. C. Ramsay, North Shields, brassfounder—Improvements in ships' and other pumps.
2717. W. Pegg, Leicester—Improvements in instruments for cutting out parts of garments and other articles, and in grinding and sharpening cutters for the same.
2718. F. Arding, Albert Iron Works, Uxbridge, agricultural implement manufacturer—Improvements in machinery for cutting, splitting, and bruising vegetable substances.
2719. B. Burleigh, Great Northern Railway, King's-cross—Improved railway crossings, as adapted to the double-headed rail, and the ordinary rail and chair.
*Dated Nov.* 23, 1853.—2720. H. R. Abraham, Howard-street, Strand,—Improvements in coffins and in hearses, and improvements in receptacles for coffins for their transmission.
2721. C. F. Stansbury, of the firm of Nourse and Co., Cornhill—An apparatus to be attached to a drill for sowing grain or other seeds for the purpose of mingling guano or other pulverised manure with the grain or seed to be sown, and depositing it in the ground at the same time with the seed, thereby greatly diminishing the quantity of guano or other manure required to produce the best fertilising effects. (A communication from T. F. Nelson, Clarke County, Virginia.)
2722. J. F. Empson, Birmingham, manufacturer—Improvements in the manufacture of wire.
2723. J. Hill, sen., and J. Hill, jun., Manchester, machine-makers—Improvements in machinery for winding, doubling, and spinning silk.
2724. J. Amos, Bristol—Improvements in preparing wood to be employed in the manufacture of casks and other vessels for containing liquids.
2725. J. Timewell, Duke-street, St. James, tailor—Improvements in cutting or shaping materials to be employed in the manufacture of articles of dress.
2726. J. Dilks, Parliament-street, Nottingham, lithographer and embosser—Improvements in bands for binding more effectually than heretofore packets or parcels of lace and other articles.
2727. E. Wilkins, Queen's-row, Walworth, gentleman—An improvement or improvements in draining land.
2728. W. B. Johnson, Manchester, manager for Messrs. Ormerod and Son, engineers and ironfounders—Improvements in steam-engines.
2729. J. D. Brady, Cambridge-terrace, Esq.—An improved mode of or a new arrangement of straps for slinging knapsacks.
2730. T. W. Kinder, Dublin, engineer—Improvements in the construction of the permanent way of railways.
*Nov.* 24, 1853.—2731. J. Lovell, Glasgow, gentleman—Improvements in the application of heat to various useful purposes.
2732. D. Chalmers, Manchester, manufacturer—Improvements in railway breaks and signals.
2733. H. Mason, Ashton-under-Lyne, manufacturer and J. Jones, Manchester, machine-maker—Improvements in machinery or apparatus for doubling, twisting, and spooling woollen, cotton, and other yarns.
2734. S. Holman, Colney-hatch, engineer—An improved construction of double-action pump.
2735. A. V. Newton, Chancery-lane, mechanical draughtsman—A novel construction of apparatus to be used as a chest-expander and as a uterine or abdominal supporter. (A communication.)
2736. E. M. Richards, Swansea, merchant—Improvements in feed-plates to be used for oxidising lead and refining silver and lead.
2737. S. C. Lister, Manningham, manufacturer—Improvements in combing wool, cotton, and other fibrous material.
2738. E. Townsend, Massachusetts—New and useful improvements in machinery for sewing cloth and other material. (A communication from W. Butterfield, Massachusetts.)
2739. W. Jones, Kilney Cottage, Swansea—Improvements in rotatory engines.
2740. D. L. Banks, St. James-place, Liverpool—Improvements in rotatory engines.
*Nov.* 25, 1853.—2742. D. Nichol, Edinburgh, stationer—Improvements in the manufacture of envelopes.
2743. J. Berry, Manchester, warehouseman—Improvements in the machinery or apparatus for manufacturing wire fencing.
2744. W. Calder, Glasgow, manager—Improvements in the treatment and finishing of threads or yarns.
2745. W. L. Brook, Meltham Mills, near Huddersfield, cotton-spinner, and C. Brook, jun., of the same place, cotton-spinner—Improvements in preparing, dressing, finishing, and winding cotton and linen yarns or threads, and in the machinery or apparatus connected therewith.
2746. A. Drew, Glasgow, calico printer—Improvements in ornamenting woven fabrics and other surfaces.
2747. J. H. Johnson, Lincoln's-inn-fields, gentleman—Improvements in carding engines for carding cotton and other fibrous materials. (A communication from G. Wellman, Lowell, U. S.)
2748. J. H. Johnson, Lincoln's-inn-fields, gentleman—Improvements in the production of printing surfaces. (A communication from A. Feldetrappe, Paris, engraver.)
2750. A. E. L. Bellford, Castle-street, Holborn—Improvements applicable to pens and pencils for writing or drawing. (A communication.)
2751. A. E. L. Bellford, Castle-street, Holborn—Improvements in rotary engines. (A communication.)
2752. C. C. A. Grenier, Paris, merchant—Improvements in the preparation of paints for buildings and other uses.
2753. E. Wilkinson, and W. Rye, Oldham—Improvements in power-looms.
2754. E. Barthelemy and T. Petitjean, Upper John-street, Fitzroy-square, mechanists, and J. P. Bourquin, Newman-street, Oxford-street, merchant—Improved means of ornamenting glass.
*Nov.* 26, 1853.—2755. J. Wormald, Vauxhall, and George Pollard, York-road, Lambeth—Improved pipe-wrench.
*Nov.* 26, 1853.—2756. W. C. Moat, Strand—Improved truss.
2757. J. Stenson, Northampton, iron manufacturer—Improvements in the manufacture of iron.
2758. G. E. Gazagnaire, Marseilles—Improvements in the manufacture of nets for fishing and other purposes.
2759. H. Coutte and J. M. Hammerbacher, Paris—Improved machine for washing linen and other textile articles.
2760. J. Roth and H. Danner, Mulhouse, France—Improvement in cards for carding.
2761. A. E. L. Bellford, Castle-street—Improvements in straining mill-saws. (A communication.)
2762. L. Cornides, Trafalgar-square, Charing-cross—Combining gelatine with certain other substances, and colouring the same, so as to produce various objects capable of resisting atmospheric influences.
2763. T. Chambers and J. Chambers, Thorncliffe Iron Works near Sheffield—Improvements in kitchen sinks.
2764. J. S. Rousselot, Nismes, electrician—Improved application of magneto-electricity for driving machinery and for neutralising the impulsive force of machinery in motion.
2765. J. M. H. Perodeaud, Rue Godot de Mauroy, Paris—Improved mode of treating peat for the conversion of the same into an artificial coal, which may be used in that state, or afterwards reduced to coke.
*Nov.* 28, 1853.—2766. W. Pritchard, Clerkenwell, cabinet maker—Improvement in buffers for diminishing the shock in the collision of railway trains.
*Nov.* 28, 1853.—2767. J. Walmsley, Accrington, manufacturer, and J. Ingham, Blackburn, mechanic—Improvements in looms.
2768. P. C. J. B. Sochet, Paris—Improvements in obtaining motive power by means of heated gases.
2769. R. H. Nicholls, Bedford, gentleman—Improvements in hoeing and otherwise cultivating land.
2772. A. Macomie, Percy-street, Rathbone-place—An ornamental piece of furniture, shaped like a vase, constructed to contain or form a writing and drawing desk.
2774. S. Hurrell, New North-street, smith—Improved machinery for measuring and winding or rolling fabrics.
*Nov.* 29, 1853. 2775. P. Kelly, West-street, Drogheda, printer—Improved apparatus for cultivating, preparing, and treating land, and for sowing seeds.
*Nov.* 29, 1853.—2778. A. E. L. Bellford, Castle-street, Holborn — Improvements in fire-arms. (A communication.)
2779. J. Moore, Lincoln, gentleman—Improvement in or addition to ploughs.
2780. J. A. Manning, Inner Temple, Esq.—Improvements in the treatment of sewage and other polluted liquids, and the products thereof.
*Nov.* 30, 1853.—2781. J. Jackson, Wolverhampton, manufacturer—A new or improved signalling apparatus.
2782. J. Elce, Manchester, machine maker—Improvements in machinery for spinning.
2783. P. A. Lecomte de Fontainemoreau, Rue de l'Exchiquier, Paris—Improvements in the construction of the Jacquard machine. (A communication from Mr. R. Rouse, Lyons.)
2784. E. K. Davis, Howley-street, Lambeth, metal pipe manufacturer—Improvements in machinery for making pipes, sheets, still-worms, and other articles from that class of metals called soft metals, as lead, tin, zinc, bismuth, or alloys of soft metals, that are capable of being forced out of metal receivers or chambers, through dies, cores, &c.
2785. J. Hewitt, Salford, machine maker—Improvements in machinery or apparatus for spinning cotton and other fibrous substances.
2786. J. Redford, Pilkington, weaver—Improvements in power-looms.
2787. R. Balderstone, Blackburn, overlooker—Improvements applicable to spinning-machines known as mules, and to machines of similar character for clearing or cleaning certain parts of such machines.
2788. J. Patterson, Beverley, engineer—Improvements in land-rollers or clod-crushers.
2789. A. Loubat, Paris, gentleman—Improvements in the construction of tramways.
2790. L. Jennings, Fludyer-street, Westminster, mechanical engineer—Improved mode of producing plain and ornamental sewing, and in machinery applicable thereto.
2791. N. de Lantsheer, Ghent—Improvements in machinery for combing flax or other fibrous material.
2792. F. S. Cole, Childown, Surrey—A smoke-consuming apparatus for enabling every fire to consume its own smoke.

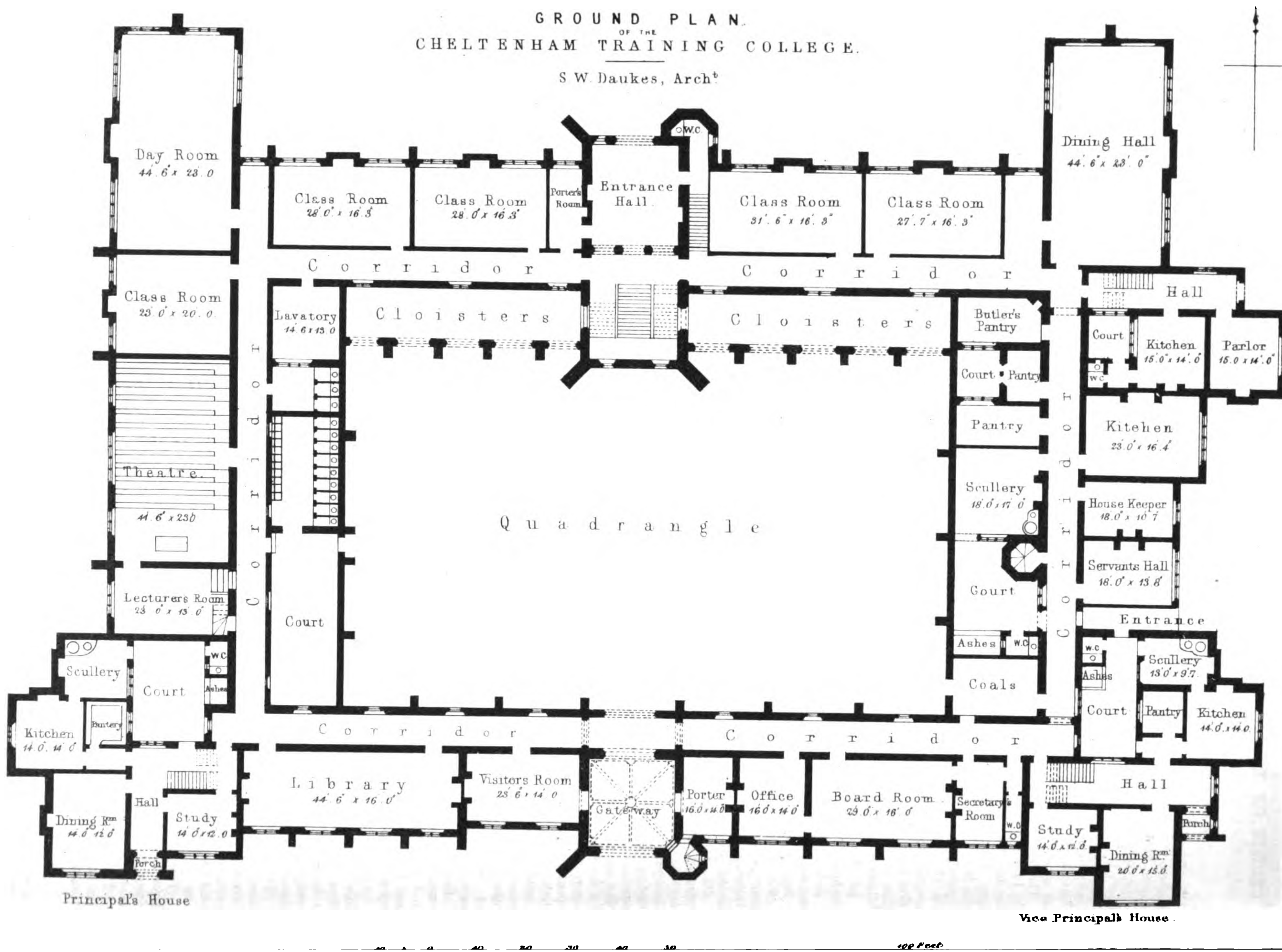
## PATENTS APPLIED FOR WITH COMPLETE SPECIFICATIONS.

2777. L. A. Michel, Paris, and Castle-street, Holborn, merchant—A system of apparatus for sawing and breaking sugar.—Nov. 29, 1853.
2819. C. W. Hockaday, Port Hall, Brighton, gentleman—Certain mechanical compound or compounds applicable as a remedy or remedies for scorbutic and other affections of the human body.—Dec. 5, 1853.
2830. J. Mold, Portland-terrace, Walworth—Improvement or addition to augment convenience by transformation and facility the different lines required in the erection or manufacturing edifices or structures by apparatus, tools, or instruments suitable for the different capacities of operatives and general surveying.—Dec. 6, 1853.

PL. 6

J.R. Jobbins

CHELTENHAM.


GROUND PLAN
OF THE
CHELTENHAM TRAINING COLLEGE.
S.W. Daukes, Archt.
Day Room 44.6 x 23.0
Class Room 28.0 x 16.3
Class Room 28.0 x 16.3
Porter's Room
Entrance Hall
W.C.
Class Room 31'.6" x 16'.3"
Class Room 27'.7" x 16'.3"
Dining Hall 44'.6" x 23'.0"
Corridor
Corridor
Class Room 23.0 x 20.0
Lavatory 14.6 x 13.0
Cloisters
Cloisters
Butler's Pantry
Hall
Court
Kitchen 15.0 x 14.0
Parlor 15.0 x 14.0
Court
Pantry
W.C.
Pantry
Kitchen 23.0 x 16.4
Training Masters House.
Theatre. 44.6 x 23.0
Corridor
Quadrangle
Scullery 18.0 x 17.0
House Keeper 18.0 x 10.7
Servants Hall 18.0 x 13.6
Corridor
Court
Lecturers Room 23.0 x 13.0
Court
Entrance
Ashes
W.C.
Coals
W.C.
Ashes
Scullery 13.0 x 9.7
Scullery
Court
W.C.
Ashes
Court
Pantry
Kitchen 14.0 x 14.0
Kitchen 14.0 x 14.0
Pantry
Corridor
Corridor
Library 44.6 x 16.0
Visitors Room 23.6 x 14.0
Gateway
Porter 16.0 x 14.0
Office 16.0 x 14.0
Board Room 29.0 x 16.0
Secretary's Room
Hall
Hall
Study 14.0 x 12.0
Dining Rm. 14.0 x 12.0
Porch
W.C.
Study 14.0 x 12.0
Porch
Dining Rm. 20.0 x 15.0
Principal's House
Vice Principal's House.
100 Feet

## CHURCH OF ENGLAND TRAINING COLLEGE, CHELTENHAM.

*(With Engravings, Plates VI. and VII.)*

The foundation stone of this building was laid by the Earl of Shaftesbury (then Lord Ashley) on April 19th, 1849. The site selected for its erection is on the north side of the town, on an ample space of ground adjoining Lady Ricketts' property (the Elms), and with a frontage to the Swindon-road, having been presented to the committee for that purpose by Miss Jane Cooke, a lady whose liberal grants to many of the public charities and benevolent institutions of that town, will cause her name to be long remembered by its inhabitants.

The style adopted is that of the Domestic Middle Pointed of the 14th century, and the whole of the design modelled after the fine old examples of the collegiate buildings of the middle ages. On reference to the engravings, it will be seen that the plan is in the form of a quadrangle; and as the arrangements are expressly adapted for the requirements of the Institution, without the least regard to uniformity, the exterior presents an irregularity of outline, which combines a pleasing and picturesque effect with a truthfulness of the adaptation of every part. The plan is divided into six distinct divisions, appropriated as follows:—

1st. A residence for the Principal, at the south-west angle of the building.

2nd. A complete residence for the Vice-Principal, at the south-east angle.

3rd. A residence for the Training Master, in the east front.

4th. The domestic offices of the College and servants' apartments, situated between the residences of the Vice-Principal and Training Master, and with immediate communication with the dining-hall.

5th. The Scholastic department, consisting of a large hall, and entrance under the tower from the north; class rooms; a spacious day-room, and lecture-room or theatre, with graduated seats; dining-hall, with great staircase to a range of dormitories over, having eighty detached sleeping apartments, and room for the assistant master. The dormitories consist of four large rooms, all communicating, in which are placed the separate bed-rooms for the students enclosed by partitions about 7 ft. 6 in. high (each compartment having its own separate window and door), and open above this to the collar of the roof, in which are placed large dormers to light and ventilate the dormitories; thus ensuring complete light and ventilation to the whole, and giving to the masters the means of quickly hearing any disturbance that may take place. The whole is also under the immediate supervision of the Training-Master and Principal, whose residences have each a door on the same floor opening into the dormitories.

6th. On the south side of the quadrangle is the entrance gateway, forming an approach to the board-room, secretary's room, and porter's residence, &c. on one side, with the waiting-room and large library on the other. The whole of these rooms have open timber roofs of stained deal.

All these various divisions, though entirely distinct, are readily approached by a light and spacious corridor of communication, extending round the quadrangle, in the centre of which is a large open area, surrounded by a cloister and battlemented walls, screening the necessary yards and offices required by each department.

The great staircase tower, forming a striking feature in the north front, is carried up an additional story for the purpose of forming an infirmary, with nurses'-rooms, bath-rooms, convalescent rooms, and dormitories, approached by a separate staircase, and having no other communication with the rest of the building.

The external walls are constructed with rubble-work, of stone from a neighbouring quarry; the dressings are executed with a fine oolite from the Cotswold Hills. The internal fittings are all of the simplest character, of stained deal and varnished.

The architect is S. W. Daukes, Esq., of Whitehall-place; and the builder, Mr. Thomas Haines. The contract for its completion amounted to 11,982*l.*

## THE LOUVRE AND THE TUILERIES.*

The advanced date of the grand design of the union of the Louvre and the Tuileries, has induced the Imperial government to reproduce the work of M. de Clarac on the two buildings, with some modifications by M. Victor Texier. Of these volumes the first alone is now before us, and we are therefore limited to considerations rather antiquarian than architectural.

The united edifice of the Louvre and Tuileries constitutes one of the grand architectural monuments of the world, and represents what the vast edifices of Luxor, of Thebes, and of Nineveh once were. We have nothing of the like class, though the ambition of Barry may, before many years, furnish us with an architectural group, colossal in character, but acquiring greater dignity from the antiquity of some of its members, and from the rich historical associations attaching to it. When the Palace of Westminster is provided with an approach of correspondent character by the new bridge over the Thames, and when it is associated or perhaps united with the Abbey and its appendages, we shall be endowed with a monument unique as that of Paris is.

The antiquity of the Louvre, as an occupied site, does not go beyond the beginning of the 13th century, or the reign of Philip Augustus; but of the mediæval structure nothing remains, and its oldest relics are of the Renaissance. These buildings have, however, been the abode of some of the most powerful monarchs of Europe—of Henry the Fourth, of Louis the Fourteenth, and of Napoleon the Great, and the scene of many important and historical events. As the abode of the arts they are, however, still more distinguished than as the abode of princes; they contain one of the finest galleries of antiquities, and invaluable collections of the gems of modern art. Here, too, the yearly exhibitions are held of the works of living French artists. Thus the name of the Louvre is that of a temple of art, and this is united with the sumptuous halls of magnificent kings to constitute one edifice, as in Egypt the palace and the temple were similarly brought into combination.

At Westminster there is neither the same mass of structure nor the same treasure of arts, but on a site consecrated for twelve centuries remain the relics of ages enshrined and preserved in a framework of corresponding style, and illustrated by the mighty men and mighty deeds of olden and of newer days. Commencing with legends losing themselves in the mist of antiquity, with such fables as those of which St. Peter is made to play the hero, the history of Westminster swells in importance even as it embraces in its sphere the events of the passing hour. As distinct in its character from the Louvre as the Memnonium was from both, we here see united the palace, the temple, the shrine, the tomb—close together, the senate-house, the judgment-hall, the scene of execution. There saints have lived and been worshipped, there kings have dwelt, and there, too, kings been brought to judgment and to death; there the rulers of kingdoms and of provinces have come to judgment—the senate of a free people and a vast empire have deliberated on the destiny of the world; there the laws and jurisprudence by which two hundred millions of men are governed, have been matured during ages. In those halls the greatest orators of modern days have declaimed—and within reach of their voices repose in death the poets, the statesmen, the warriors, the kings, of twelve centuries. The artist looks on the Louvre with veneration, as a wondrous triumph of the resources of art; but the halls of Westminster are reverenced as a temple sacred to freedom by the most powerful race in the world, wherever its sons may be found—in Europe, in America, or in the still newer world of the Southern Seas. Its traditions govern the senates and courts of the many sovereign commonwealths of the United States, with the same power as they do at home, and its inspiration is sought by embryo communities scarcely emerged into civilisation. From Liberia, Mosquitia, Hawaii, Sarawak, or even from the household community of Pitcairn's Island or Bonin, the principles of organised government will be communicated to new regions and be a blessing to new generations. The Walhalla, which Lewis of Bavaria thought to found on the shores of the Danube, the Hall of Glory, has stood for centuries on the banks of the Thames.

It is in these reflections we seek for comfort when we consider how, by the consolidation of architectural and artistic resources,

* 'Description Historique et Graphique du Louvre et des Tuileries.' Par M. le Comte de Clarac. Paris: à l'Imprimerie Impériale. 1853.—['Historical and Graphical Description of the Louvre and the Tuileries. By the Count de Clarac. Paris: Printed at the Imperial Printing Office. 1853.]

the kings of France have at length succeeded in bestowing on Paris one grand, crowning monument. The completion of this vast enterprise, vainly projected by Louis the Fourteenth and his successors, and but begun by the Emperor, will be a distinction to the reign of Louis Napoleon, whatever else may befall. This single undertaking would have been enough to entitle Paris to the palm in the career of architecture; but it is connected with such a gigantic scheme of street construction, as will renew the claim of Paris to the honour of being the most magnificent capital of Europe. The example of Paris had caused great improvements in London, Berlin, Munich, and Brussels, and many inferior cities of Europe and America were greatly enriched; and it may be after all that this new Paris may cause fresh exertions. There are the elements for this in London already. The Crystal Palace at Sydenham has stimulated a new class of enterprise, and the consequences of the abolition of the window duties are now beginning to produce fruits. What is done in Cannon-street is only an earnest, in comparison with Paris; it is only an infantile beginning, but it will be followed by worthier results. A larger class of street-house can be constructed, and not only are various edifices designed for purposes heretofore unthought of or impracticable, but plans are in progress for new thoroughfares and avenues of a more distinguished character.

The isolated public buildings in progress or contemplation, although important, would not alone be sufficient to redeem the character of our street-architecture, but they will be accompanied in many cases by suitable approaches. Whereas, formerly, the ambition of architects was limited to isolated monuments, often inconsiderable, we have to notice as a characteristic of the present day long-continued or connected façades and avenues. Many causes have contributed to this; among others, greater attention to street-architecture; but the crowning influence has been the political necessity which has dictated to Louis Napoleon the widening of the streets of Paris as a military resource against popular insurrection. In London, the necessities of an unexampled population and a vastly increasing traffic are equally imperious, and the formation of a few junction lines and the completion of the projected routes will give a new character to the great thoroughfares. New Cannon-street will be connected with Blackfriars-bridge; Carey-street will in time unite Cheapside and the Long-acre line. Victoria-street, Clerkenwell, and Victoria-street, Pimlico, will be avenues to other improvements. Although Cannon-street has entailed a cost of 200,000*l*., yet, in other cases, first-class thoroughfares will be cut through inferior property of a low class for ground-sites, and affording, in the upper stories of the large houses or hotels, accommodation for the working-men and others at low rentals.

Whatever may be done in our streets, nothing will give us a rival to the Louvre and Tuileries, to the formation of which the labour and genius of three centuries have contributed. Originally the Louvre and the Tuileries were separated by a small river and the wall of the City of Paris, and both had at one time been beyond the town bounds; one palace taking its name from a wolf-hunting station in the woods, and the other from some tile-kilns and fields. Saint Louis seems to have been the first king who inhabited the Louvre, and in the reign of Charles V. it was brought within the fortifications of Paris. Francis the First began the reconstruction of the Louvre under the direction of Pierre Lescot, which was continued by his successors. In 1564, Catherine de Medicis built a chateau in the tile-fields beyond the fortifications: Philibert Delorme was the architect.

Henry the Fourth, notwithstanding the intervention of the city wall, united the grounds of the Louvre and the Tuileries, and even connected the buildings by a gallery. In 1624, under Louis XIII., the reconstruction and extension of the Louvre was put under the charge of Lemercier.

Louis XIV. employed the architect Levau to raise a new façade for the Louvre on the river side, and likewise an eastern wing. In 1664, the plan of Claude Perrault for the decoration of this wing by the colonnade was adopted. Wren, in his tour of continental study, availed himself of the opportunity of examining the designs of Perrault. Throughout the 18th century the works of the Louvre were prosecuted, but it was under Napoleon that the completion of the Louvre was chiefly effected, though the decorations were in progress much later.

For the great plan of the union of the Louvre and Tuileries, a competition was opened from 1806 to 1810, and the designs of Messrs. Percier and Fontaine were adopted. They were put in charge of the works, and the second northern gallery of junction was commenced. These works, however, have been interrupted from time to time, until the desire of employing the population of Paris has led to their active resumption and approaching completion under new auspices.

The volumes which describe these works, and which issue from the Imperial press, are the productions of the late Count de Clarac, a distinguished French archæologist. This gentleman was forced to emigrate at an early age, but managed to pursue his studies in Switzerland and Germany. Although compelled by the circumstances of his position to join the army of Condé, he neglected no opportunity of showing kindness to his political adversaries, and particularly to the wounded of the French armies. He afterwards served for a time in Poland. These military studies did not, however, cause him to neglect the cultivation of drawing, nor that of the ancient and modern languages; of the latter, he was acquainted with English, German, Italian, Spanish, Portuguese, and Polish, besides his mother tongue. He likewise gave some attention to chemistry, mineralogy, and zoology; studies which, nevertheless, proved to him of considerable value afterwards in his archæological pursuits, more particularly when he wished to ascertain the technical processes of the ancients, or to discriminate between the materials which they employed.

On an amnesty being granted to the emigrés, Clarac returned to France, and continued his studies at Paris, devoting himself to Greek. His patrimony having been lost, he was obliged to have recourse to literary occupations. While attending the gratuitous public courses of ancient history and literature, at the Institute, he became acquainted with some of the more distinguished students and professors, which had an influence on his advancement, as he was recommended to Queen Caroline Murat to superintend the education of her children. To the student of limited means, no facilities for acquiring information are to be found here correspondent to those of Paris. The favourite, but false idea, that educational institutions are not valued unless they are paid for, stands completely in the way of the poor but zealous student. The pursuit of knowledge under difficulties may be well illustrated from the experience of England,—the indomitable application of genius, or the chapter of accidents alone opening a career to the aspirant. The man of inferior or mediocre powers, the man of the rank-and-file of science, is left to scramble on as he can. In Paris, Faraday would not have been abandoned to the chances of life for the opportunities of continuing his studies. There are schools where the greatest professors teach, and the poorest mechanic can enter. In London, the only gratuitous courses we have are those of Gresham College, which are a farce, and those of the Royal Academy, which are not accessible to the public. The schoolmasters' classes of University College are hedged-in with restrictions; and as to the Swiney course on Geology, that is under the regulations of an eccentric founder. The Hunterian, and some other medical lectures, we do not dwell upon, as they are limited to a special class. The superior wealth of the population in some degree remedies the defects, but the state of affairs is by no means creditable to the country.

The establishment of cheap classes and schools amounts to little more than a confession and palliation of the evil, and it amounts chiefly to the schools of design, the school of practical geology, and the schools of navigation, few in number. The Royal Academy still bears away the palm, and its experience is sufficient to show that education may be zealously pursued without the degradation of a money payment. High art alone can be studied without expending a small capital on instruction fees; and assuredly the Royal Academy, the National and Vernon Galleries, the British Museum, the British Institution, and the other galleries, are not in want of students. With regard to mechanics' institutions and young men's classes, laudable as the motives of the founders are, they are inefficient substitutes for what is really required. We want evening colleges for gratuitous general and applied instruction. These we may wait long to obtain; but it is scandalous that, with the means we have, the higher branches of study are not better cared for in the metropolis of the world. The British Museum admits students to its Elgin and Townleian collections, and professes so to do to its other galleries; but why should it not, as has been often advocated, charge its officers with the task of giving occasional gratuitous lectures on the collections under their charge? There is one objection we are aware of to gratuitous lectures, and that is the inconvenient congregation of the public that would follow. With regard to the objection of the inroad that lecturing would make on the time of the keepers, we think little of that, for if facilities were given to the public to lecture as well as to attend lectures, there never would be a reserved day without its lecture. Those architects and others, who at the Royal Institute of British Architects have delivered learned discourses on the Parthenon, to the great advantage of the members of the profession who heard them, would willingly give the same explanation of their views before a miscellaneous audience, having the benefit of referring to the relics of the Parthenon distributed around them. How much, too, would archæology gain by the illustration the treasures of the Museum would receive from Layard, Fergusson, Fellowes, Rawlinson, Wilkinson, or Hinckes. There the theorist could expound his system, there new illustrations of archæology would be rapidly spread among men none the less zealous because they cannot afford the limited subscription of the Society of Antiquaries. Geology and natural history would benefit by such freedom. The public spirit which prompted Saull and Bowerbank to throw open their collections, and to give explanations of them, would not be wanting; and many who want means or time to form museums, would gladly give their assistance in illustrating the museums belonging to the public.

The public require not only gratuitous lectures, but access for men of science to the public collections for the purpose of lecturing. Thus, not only the strictly public institutions of the British Museum, National Gallery, Vernon Gallery, Museum of Practical Geology, Hampton Court, Kew Gardens, and Greenwich Observatory, would be made useful, but other proprietary institutions might become available. Through the chicanery and quibbling of the judges and lawyers, the act for exempting scientific institutions from taxation has been converted into an utter abortion, and it is said that some institutions will be closed in consequence of the withdrawal of the exemption enjoyed under the act. It is exceedingly desirable that the measure should be re-enacted, and it might be accompanied by stipulations enabling the Board of Education or Board of Trade, to obtain correspondent advantages for the public. Thus, the Royal Botanic Society already admit as a favour students of the schools of design and of the Pharmaceutical Society to their gardens in the Regent's Park; but for relief from their rates, they might be induced to give facilities for public lectures on botany, of which too their fellows would have the advantage. The Zoological Society might make correspondent terms, and there are many institutions which have collections most valuable for the illustration of the lecturer. By such measures we should be enabled in some degree to rival Paris, and should become possessed of what we much want—schools of astronomy, natural history, archæology, the oriental languages, and history. The only school of archæology in England is that munificently founded at Cambridge by Mr. Disney, and who proposes to supply another public want by establishing in London a school of navigation, nautical astronomy, naval architecture, and hydrography, in connection with the Cosmos Institute in the Great Globe in Leicester-square. It is lamentable we should be without such schools, for we want neither money nor buildings, neither lecture-rooms nor illustrations, any more than we want lecturers. What cost the French authorities many thousands a-year, may here be obtained by a simple effort of the administration. Indeed, the want of means for supplementary and superior instruction leads to those great and public-spirited exertions of individuals in gratuitous lecturing, in the reading of papers and memoirs, and in the support of literary and scientific institutions.

A very serious consequence of the want of public instruction is, that the appointments of curators in our public institutions often become jobs, or the inferior institutions are obliged to put up with a monkey-stuffer to take care of their collections.

We have taken advantage of an incident in the life of M. de Clarac, as of others connected with this history of the Louvre, to show how they do things better in France; for we have so long co-operated in many successful public movements, that we are not afraid of agitating when an opportunity presents itself. France spurred us up to the establishment of schools of design and industrial schools; perhaps she may shame us to more magnificent streets, and to structures more truly approaching the character of palaces than those we so call. M. de Clarac obtained a great advantage from his appointment under the Murats, as it led him to Naples, where a fruitful field of archæological study was opened to him. He was there for six years, and had under his charge the exploration of Pompeii, in which he distinguished himself.

On the return of the Bourbons to France he obtained the opportunity of accompanying the embassy of the Duke of Luxembourg to the Brazils. There he occupied himself with natural history, the representation of nature and ethnology. Among his drawings, one of a virgin forest on the banks of the Rio Bonito, since engraved, has been quoted by Baron Humboldt as the most faithful representation he ever saw of the vegetation of the new world. In his exploration of the Oyapoc river, M. de Clarac made himself acquainted with the language of the aboriginals, and not only made a large collection of arms and other objects, but constructed many models, in which he was very expert. He was indeed so fond of mechanical modelling, that he pursued it as a relaxation from his constant studies, and worked as hard at his lathe as if he had earned his living by it, though his chief zeal was to supply toys to the children of his friends.

On his return to Paris he was appointed to succeed Visconti as conservator of the Museum of Antiquities. In this capacity his chief and admired work is his 'Museum of the Ancient and Modern Sculptures,' on which he was employed for twenty-five years, and which he left incomplete. As accessories to this are the 'Description of the Royal Museum of Antiquities in the Louvre,' and the 'Manual of the History of Art among the Ancients.' In his works he received the assistance of the government,—another peculiarity we may observe of France. In 1833, M. de Clarac visited England, and he was so deeply interested by its numerous collections, that he projected other visits, but his home occupations prevented him. He died suddenly in 1847, having corrected proofs in the morning.

The 'Historical Description of the Louvre' now before us, is a service rendered to all architects, and particularly to those of France, as it is likewise a contribution to the history of the art in France.

## APPLICATION OF PAINTED GLASS TO BUILDINGS IN VARIOUS STYLES OF ARCHITECTURE.

The discussion upon the above paper, read at the Royal Institute of British Architects, by Mr. C. Winston (see *Journal, ante* p. 18) was commenced by the Chairman (Mr. T. H. Wyatt) inviting Mr. Trotman to give some explanation of several drawings exhibited by him.

Mr. Trotman proceeded to describe the subjects in chronological order. The first was one of a series of four subjects relating to the history of Christ, from the Church of Rivenhall, Essex, which had been procured from Tours some years ago by the present vicar, for the decoration of the church. These specimens dated from about the beginning of the 12th century. The whole of the ground colour was a rich bright blue; a quantity of green was intermixed with this in the figures, and great relief and brilliancy was given to the design by the introduction of characteristic lines of white. Mr. Trotman next referred to similar specimens from Canterbury Cathedral, and to four subjects from York Cathedral, the most perfect, out of seven, representing the corporeal Acts of Mercy—Giving shelter to the Houseless, Visiting the Sick, &c. Two large drawings of windows in the Church of West Wickham, Kent, representing the Virgin and Infant Saviour, and the Virgin and St. Anne, were next noticed; these being of the latter half of the 15th century. A Nativity from Great Malvern Church; one of the heraldic badges from the East end of Henry the Seventh's Chapel; the Visit of the Queen of Sheba to King Solomon, from Fairford Church, Gloucestershire; and an interesting specimen from the Hammermen's Chapel in the Cowgate, Edinburgh, representing the National Arms of Scotland ("the Scottish Lion"), were then referred to and described; and Mr. Trotman further directed attention to a series of small drawings of painted glass from the Continent, including specimens from Paris, Rouen, Brussels, Cologne, &c. Mr. Trotman expressed his concurrence in the views of Mr. Winston generally, and regretted that some false principles should have been promulgated on the subject of glass painting by Mr. Redgrave, in the Catalogue of the Contents of the Museum of Ornamental Art, that gentleman having objected to the introduction of shadows, and observed that "glass painting should consist of flat tints without shadow." On the contrary, he (Mr. Trotman) considered that if shadow were to be omitted, there must be an end of glass painting; and certainly the folds of drapery, &c., could not be better represented by outline than by shadow, especially as painted windows must be seen from a great distance. The real question was, to what extent the principle of shadow and rotundity should be carried. Some of the medallions in Canterbury Cathedral were in simple outline, whilst the east window of St. Bride's Church (the Descent from the Cross, by Muss, after Rubens) was remarkable for depth of shadow; and each of these alike failed to realise the resources of glass painting. The object to be attained was the highest degree of brilliancy consistent with a high degree of art; and he therefore could not sufficiently admire the sentiments of Mr. Winston, who had given a severe blow to the merely antiquarian view of the subject, and to the fallacy of direct imitation of mediæval glass painting. Ward and Nixon, in their work at Westminster Abbey, were to be commended for not adhering too rigidly to the old models, although they had not succeeded in developing all the resources of the art. As a general principle, in order to insure that brilliancy which glass offered, it was necessary to treat every subject with considerable subdivision, and great attention to detail. In some modern glass painting much of the interest was lost by a neglect of accessories and details, and the modern glass at Cologne Cathedral was objectionable in this respect, as it consisted of single figures with large masses of drapery. By subdivision he meant a more complicated style of composition than was necessary in any other kind of painting. Thus, the Church of St. Vincent de Paul, at Paris, possessed some of the finest specimens of modern glass; but from the figures being too colossal, and occupying each one window, the subjects were less interesting, and less brilliancy was obtained, than a different treatment would have insured. The effect of colossal figures in glass painting tended to diminish the apparent magnitude of the building, and was exemplified at the east end of the Chapel of Eton College, where the windows of Mr. Willement had an injurious effect. Upon the whole, he considered it would be very wrong to study the specimens exhibited with a servile regard to precedent, but rather as offering so many steps towards the attainment of a good and effective style. The human figure must be considered essential, either singly or in groups, as windows representing only foliage, &c., could not be interesting, and should rather be classed as ornamentation than art. The subjects should be on as small a scale as was consistent with distinctness, and, so long as the necessary brilliancy was not detracted from, there was no limit to the application of shadow. Useful hints might be taken from sculpture in relievo, and from such works as the Bronze Gates by Ghiberti, at Florence, care being taken to render the figures important and the accessories subordinate.

The Rev. J. L. Petit concurred with Mr. Winston, whose object, it appeared, was to combine the merits of the glass of the 12th and 13th centuries, with a degree of art and beauty not then obtained; and in so doing he would not violate the principles of that era, when the artists got the best models and drew as well as they could. Servile imitation should be scrupulously avoided, and if works of art of a high character were unsuited to Gothic buildings, then the Gothic was not the style for the age. The architect should make himself independent of the painter and sculptor; but when their aid was offered in the finest art, he should be able to exalt that art, and so to place the specimens of it that they should appear exalted even in their subordination to the architecture. Thus the Grecian, the Roman, and Italian styles, admitted of the application of art in its highest character; and so the mediæval architecture admitted the best specimens of art that could then be obtained. If, on the contrary, at the present time Gothic and the highest art were incompatible, that style ought not to be pursued. Architects should endeavour to revive, to modify, and improve it; but if they could not make it a noble style, let it be abandoned.

Mr. E. T. Parris drew attention to the cartoons of Raffaele as being, in his opinion, composed upon principles similar to those which should regulate glass painting. In those works every relief was gained by an opposition of colour, rather than by shadow; and, as in the best stained glass, the horizon was very high, its line being always broken by colour or form of some sort —in one instance by a house on fire, the object of introducing which could only proceed from some artistic principle. He fully agreed with the remarks of Mr. Winston. Many painted glass windows had been erected from his (Mr. Parris') designs, but he was generally trammelled by the person who had the order. He had declined the work at Westminster Abbey, executed by Mr. Nixon, for this reason.

Mr. Papworth observed that the discussion had been directed rather to the best styles of glass painting for mediæval architecture, than to "the proper application of painted glass to buildings in various styles of architecture." The question to be laid before them by Mr. Winston, was whether they ought to have any stained glass at all. Stained glass either was or was not a necessity to the architect, and it would be well to settle this as a principle. In the majority of the works of modern architects the question was a difficult one. They could not all build churches and fill the windows with stained glass, or decorate old churches in the same way, their business being rather with a great variety of public and domestic buildings; and the difficulty was whether painted glass was applicable to domestic uses, and if so, what style should be adopted. The reply to this question would answer the previous inquiry—whether they were to have painted glass at all. He considered there was a great deal of merit in that kind of glass which had been largely introduced since 1800, consisting chiefly of ground glass, with arabesques and other ornaments painted upon it. Probably Mr. Winston would state whether he thought that kind of painting applicable to the wants and purposes of the present day.

Mr. Alfred Bailey observed, that there was one variety of mediæval painted glass which had not been referred to. This was to be found in the minor towns of Central Italy, and appeared to have been executed late in the 15th century, and designed on totally different principles to any other kind. They resembled in general design the English glass of the 13th century, but instead of the colours being arranged in small lines, they were introduced in masses, giving a broad effect of colour. Figures were introduced but sparingly, and generally small; which was remarkable, considering the perfection attained in the fine arts at that period. Mr. Bailey referred to specimens at Arezzo, Perugia, and Assisi. With regard to the question of the style of art suitable to painted glass, he believed that a finished pictorial composition was not suited to that material. In S. Petronio, at Bologna, two of the grandest figures designed by Michael Angelo were introduced in stained glass, with a great deal of light and shade, and produced a most unpleasant effect. Mr. Winston did not object to shadows, perspective, and even landscape backgrounds, but it required great study to know what effect a picture would have, and whether it was a fit subject to permit the passage of light. None of our best artists would like a good picture to be placed in the situation of a painted blind. Architects often neglected to consider where they should place painted windows, and a very bad effect was sometimes produced by having them at the level of the eye. A grand and broad effect of colour should be sought for rather than a result resembling patchwork; and the architect should especially remember the importance of painted windows, as striking the immediate attention of the spectator on entering the building; and, consequently, if these were too much elaborated, they must detract from the effect of the building itself.

Mr. Twining was of opinion that stained glass should not be made to compete with oil-paintings, but should be rather of an ornamental character. Painted windows being generally placed at a considerable height, were not adapted by position to receive representations of landscapes,—especially of flat scenery; and moreover architectural subjects seen in an elevated position must be represented by false perspective. The representation of groups on different panes was objectionable, because the metallic slips which formed their outlines were necessarily of the same thickness throughout.

Mr. Hesketh called attention to some books containing a series of original illuminations from MSS. on vellum, collected by Major Macdonald in Arabia, Syria, and Italy. The beauty of these illuminations, and the principles upon which they were designed and coloured, admirably adapted them for imitation in glass painting. In reference to paucity of subjects for stained glass, he might suggest the metaphorical subjects abounding in the Scriptures,—such, for instance, as the meeting of Righteousness and Peace; and many others, which Flaxman had mentioned as never having been treated by artists.

Mr. Talbot Bury regretted that a sufficient amount of talent had not hitherto been brought to bear upon glass painting. He agreed with Mr. Winston that those designs in which the light was centralised were failures, because the objects represented must be transparent or semi-transparent. One obstacle to enlisting talented artists as glass painters arose from the mania for collecting specimens of old glass of any kind, and putting them together as "ruins,"—or copying and imitating them. A first-rate painter would not be fettered by a glass-cutter, or by any rules or dogmas as to the style of drawing he should adopt. The advice of the artist was too often neglected, and people would not give sufficient remuneration for his work—that was the true cause of the inferiority of the art. It had become a matter of competition, and the person who gave the most glass and the most colour for the money, was employed, without regard to merit. Individuals, committees, and the clergy, were alike ignorant of the principles of the art, and were too often influenced by a mere prejudice in favour of antiquity. He wished, therefore, that Mr. Winston's paper could be extensively circulated, for the dissemination of good taste. So long as nine-tenths of the world preferred the barbarisms of antiquity to the finest works, he did not know what could be done to improve the art of glass painting. Mr. Bury referred to a drawing of the east window from Lincoln's Inn Chapel, &c., as an illustration of bad taste in modern work. He agreed with Mr. Winston that by an artist the mullions dividing a window might be overlooked; but that was not the case with others, and when, as in some instances, a canopy or other object on the glass was completely divided by a mullion, as in a German specimen among the drawings, the effect was bad.

Mr. Winston expressed the great pleasure and instruction he had derived from the discussion on the subject of his paper. Not being a professed artist, he had been obliged to study the subject in a desultory way, and rather by actual observation and comparison than by deep reflection. Hence, he had not given his attention to the subject of painted glass for domestic purposes. He agreed with Mr. Trotman as to the principle of subdivision, and in his objection to colossal figures. Some of the figures in ancient windows did not appear so large as they actually were, in consequence of their skilful treatment by the artist. A figure of St. Christopher, at Strasburg Cathedral, of the 12th or 13th century, was nearly 14 feet high; but the drapery was broken in every direction by lines of different colours, and there was little or no shadow; so that the general effect to the eye was similar to that of a mass of colours, or a regular pattern. The remarks of Mr. Parris, as to the Cartoons of Raffaele, were new to him, and he quite agreed with them. Sir C. Eastlake had also pointed out the manner in which Raffaele had adapted his compositions to their execution in a material incapable of any great effect of depth. He agreed with Mr. Papworth that ornamented ground glass had much merit. It looked somewhat flimsy; but it was very pretty, and certainly better than plain glass. It might be a question how far painted glass was suited to modern domestic habits. Mr. Winston mentioned the round patterns seen in German glass, and Mr. Powell's patent for stamping glass. The weight of this latter material, however, rendered it objectionable for a window to be raised and lowered, but it was suited to staircase windows, &c. What he had stated respecting the flat and rotund style of glass painting should be borne in mind; and the material should not be forced beyond its capabilities. The early MSS. certainly contained valuable hints in their illuminations. Mr. Bury's remarks on the question of the cost of good windows were perfectly true; and it was impossible to deny the superiority of foreign stained glass. The specimens in the Great Exhibition of 1851 amply proved this. These were works produced under the fostering patronage of powerful individuals. It should be remembered that not only was there an objection to pay adequately for good works, but that a vast deal of money was wasted on bad works. It would be better to have one good one than fifty bad ones. The erection of one fine window in a church was sufficient for a generation, and doing more than that in an imperfect way, was only impeding what might be better done hereafter. It was the province of architects to elevate this art by impressing its importance upon their employers; and he felt sure that there would be no want of skilful designers, if proper encouragement were offered to them.

The Chairman, in proposing a vote of thanks to Mr. Winston, concurred in the necessity of architects forcing their employers in every possible case to encourage a higher style of art. He would never himself be a party to the erection of a stained glass window, unless he had a choice both of the cartoon and the artist. Their difficulties had arisen from a combination of circumstances, —of which not the least was the fact, that the whole world professed to be critics, especially in mediæval art, and acknowledged no judgment but their own. He took occasion to refer to the new window in Mr. Hope's church, in Margaret-street, which he described as most unsatisfactory, though he had met several persons who considered it the finest of modern specimens.

## SAVINGS BANK, PROVIDENCE, RHODE ISLAND.*


The annexed engraving represents an edifice which was commenced early last year, and was designed by the Messrs. Hall, architects, of Providence and Boston, under the sanction of the building committee, Messrs. R. H. Ives, Isaac Brown, and Seth Adams, jun. We thus particularise the committee for their good taste and judgment in the selection of the design. The building, on the exterior, is wholly of granite, executed in the best manner, agreeably to the plans and drawings of the architects, and under their directions. The location is on South Main Street, between the Providence Bank Building on the north, and the mansion of Isaac Brown, on the south. The building is, of itself, 37 ft. 6 in. frontage, and 55 feet deep, raised on a basement of about 6 ft. 6 in. in height. The basement is in courses of split granite grooved ashlar; and the superstructure is wholly of hewn granite, hammered in the best manner, finishing around the building with a full, elaborative and dental cornice. The end of the building facing on the street, finishes with a pediment.

## THE STATE CAPITOL OF TENNESSEE, U. S.†

The site for this building is, perhaps, the most beautiful in the world. Imagine a hill within the centre of the city, rising in every direction to the height of 197 feet above the level of the Cumberland river at Nashville, 4 feet of its crest being removed, and leaving a plateau of solid limestone for the construction of a building. You look down upon the city beneath your feet, and the prospect beyond is bounded on all sides by a far distant amphitheatre of mountain ranges. Neither Rome, from her seven hills, the Athenian Acropolis, nor the cape at Colonna, affords so splendid a site for an Odeum.

In plan and elevation, the design and whole character of the architecture is essentially Grecian, consisting of a Doric basement, supporting, on its four fronts, porticoes of the Ionic order, taken from the example of the Erectheum at Athens. In the centre of the building rises a tower above the roof, to the height of 80 feet, the superstructure of which is after the order of the Choragic monument of Lysicrates at Athens. The whole structure is composed of fossillated limestone, hewn and chiselled from quarries in the neighbourhood of Nashville, the blocks of stone weighing from 6 to 10 tons.

The various chambers, halls, and porticoes, are arched throughout. The rafters of the roof are of wrought-iron, having a span of the whole width of the building, being supported by the interior walls at the north end, and by the columns of the southern division of the building, the whole covered by thick sheets of copper. In plan, the basement story is intersected by longitudinal and transverse halls, of wide dimensions, to the right and left of which large and commodious rooms are to be appropriated to the uses of the Governor, Supreme Court, Secretary of State,

* Extracted from 'Gleason's Pictorial Drawing-Room Companion.'

† From the 'Nashville Banner,' U.S.

Federal Court, &c. The crypt, or cellar story, in part, is to be used as a depository of arms.

From the great central hall you approach the principal story by a double flight of stairs, which leads to the chambers of the Senate and the House of Representatives, to the library, and to the other rooms in connection therewith. The committee-rooms of the House are disposed on the same floor to the right and left, communicating immediately with it and the lobbies. Over these rooms the galleries are placed. Flanking the public hall private stairways are constructed, leading from the crypt to the various stories, and to the roof.

A geometrical stairway leads from the level of the road to the top of the tower, where you land upon an arched platform, which is intended for an observatory. The tower is built up from the foundation of solid stone, containing four niches in the basement and eight in the principal story, with spacious halls leading to the right and left. The principal stairway, which is 30 feet in width, leads from the centre of the building to the Hall of Representatives, Senate chamber, and Library.

The Hall of Representatives contains sixteen fluted columns of the Roman Ionic order, 2 ft. 8 in. in diameter, and 21 ft. 10 in. in height, from the level of the galleries over the committee-rooms. The shafts of these columns are all in one piece.

A chief beauty and convenience in the design of the principal story, so much superior to the plan of the Capitol at Washington, is, that the committee-rooms are on the same plane with and surrounding the Hall of Representatives; the dimensions of this room are 100 feet by 70 feet; height of ceiling from floor, 42 feet.

The forum of the House of Representatives consists of a semicircular platform 3 feet in height, forming three steps, upon which there is a screen of East Tennessee variegated marble, 13 feet in height, 12 feet wide, and 1 foot in thickness; on the top of which is a cornice and blocking-course, surmounted by an eagle resting upon a shield of cast-iron, bronzed and gilt. One foot from each end of the screen, on a die of black marble, the Roman fasces are placed, which are of beautiful variegated East Tennessee marble, 1 ft. 2 in. in diameter, and 10 feet in height.

The Senate chamber is of an oblong form, 35 by 70 feet, having pilasters of the Ionic order, with a full entablature; the ceiling of this room is formed into radiating panels or lacunaria, and is 43 feet in height; there is a gallery of 12 feet in width on three sides of the room, supported by twelve columns of variegated East Tennessee marble, with white capitals and black bases, from the Erectheum. The forum in this room consists of a platform of two steps; the speaker and clerks' desks are of fine East Tennessee marble.

The Library is immediately opposite the Senate, and is 35 by 35 feet; on each side there are committee-rooms, communicating. Over the arches of these rooms are alcoves for books, papers, and archives of the State; the doors and windows, which are of a large size, are all of solid white oak, moulded, pannelled, and ornamented with devices; the windows are all double, divided by stone pilasters, enriched with consoles, ovolo, and spears.

All the floors are groin-arched, and flagged with rubbed stone; hanging stone steps throughout the building. The building stands upon a rusticated basement, 18 feet in height, which is tooled on all fronts, and the superstructure is of rubbed stone inside and out. All the walls of the foundations are 7 feet in thickness, and those of the superstructure 4 ft. 6 in.

The building is in the form of a parallelogram, 140 feet by 270, surrounded by a terrace 17 feet in width and 6 feet in height, flagged with stone, with flights of steps in the centre of each front, opposite the doors of entrance.

There are twenty-eight fluted columns, 4 ft. 8 in. diameter, ornamenting the four porticoes, with elaborately wrought capitals. The north and south porticoes are finished with pediments containing ceilings of stone, and the east and west porticoes are surmounted by parapets. Those of the north and south are octastyle, and those of the east and west hexastyle. The columns of the principal story rest upon bases 6 feet square.

The water is conveyed from the gutters of the roof by means of cast-iron pipes, 8 inches in diameter, buried in the walls. The glass, which is of double thickness, is of a superior quality, and was made at the works near Knoxville, East Tennessee. Indeed, all the materials are furnished by the State of Tennessee. The whole building will be heated with furnaces communicating with hot-air flues within the walls.

## M. LECLERE.*

Monsieur Leclere, it appears, carried off the *Grand Prix* in 1808, at twenty-two years of age—a very unusual circumstance in the life of an architect. The programme of the competition was a large establishment of public and private baths for the capital; and the manner in which he had carried out his conception was most remarkable. During his residence at Rome the studies of the young *pensionnaire* were always well chosen, and conscientiously and well executed. His restoration of the Pantheon was the crowning point of his many researches amongst antique monuments, and placed him among the most distinguished architects who had given their attention to the restoration of that magnificent building of the Augustan age. M. Leclère also made an interesting collection of studies on the modern edifices of Italy. A student in the celebrated school of Percier, whose taste and learned maxims extended throughout Europe, the pupil, after his return to Paris, was attached by his worthy master to the administrative department of the Conseil des Bâtimens, in whose works he took part for thirty years; and when the celebrated Professor was unable to continue his labours in the school, he entrusted them to the direction of M. Leclère. These circumstances were the chief cause which prevented M. Leclère from being engaged in the erection of more public buildings; however, he executed in France many large country houses, and in Paris some of the finest houses of modern times. One of the most remarkable monuments in the Eastern Cemetery of Paris, that of Casimir Pèrier, was designed and executed under his direction. His brilliant début as pupil, and his subsequent works as *pensionnaire* of the Academy, were followed by M. Leclère's early entrance into the Institute, where he was called upon to take part in the works of the Professors in the School of Fine Arts, who appointed him "*Archiviste.*" Of a kind and conciliating disposition, full of love for his art, persevering in those principles which he believed to be the best, encouraging those pupils who were studious and distinguished, M. Leclère well deserves all the encomiums which accompany his memory to the tomb. M. Leclère presented to this Institute some very important tracings of the constructions of the Pantheon at Rome, next the portico, with a view to explain whether the portico formed a portion of the original design, or was a subsequent addition of a later period; they are preserved in our collection of original designs and drawings, which are now forming a very valuable series.

On the 26th of December last his remains were accompanied to the Cimetière du Nord, amid the regrets of his colleagues, his friends and his pupils; and eulogiums were pronounced by Messrs. Raoul Rochette, Vinet, Visconti, and Isabelle.

## M. VISCONTI.*

In the funeral cortège of M. Leclère, just noticed, the name of Visconti will be remarked, as one of those who addressed the assembly at the grave of his friend; within one short week Visconti was himself cut off suddenly by an apoplectic fit, and borne to the cemetery of Père la Chaise amidst the grief of all France—and may it not be added of all Europe. M. Visconti was present on the 29th of December at the first meeting of the Commission for the Exhibition of 1855, at the Palais Royal, under the Prince Napoleon, and remained there from 1 to half-past 3 o'clock; he then left, and went to his office at the Louvre with a friend, M. Semard; with him he had an animated conversation, and having to dine out, he asked for his carriage, but it being then only half-past 4, and earlier than the time he usually quitted the works, it had not arrived, and he sent for a hackney carriage. M. Semard saw him into the carriage, and it drove off, and soon reached his residence; the coachman got down and opened the door, when he found M. Visconti quite dead.

He had just reached the culminating point of glory for an artist by having had confided to him the completion of the Louvre, whica, had occupied the genius of French architects for two centurihe He had reaped the fruits of laborious and profound studies in the very highest departments of our art, by solving the problem which seemed to present difficulties apparently irreconcileable and almost insurmountable; and he had commenced, and to a great extent carried into effect (to the height of 30 feet in some parts) with in-

* Communicated to the Royal Institute of British Architects by the Honorary Secretary of Foreign Correspondence, January 1854.

conceivable rapidity, the outlines of his grand design, which united all suffrages, and promises to render the Palaces of the Louvre and Tuilleries the finest sovereign-residences in the world. At the same time it must be confessed that the conception of other architects, as Percier and Fontaine, and more recently, of M. Dusillon, had considerably assisted him in the solution.

I had from his own lips the following account of his appointment to this important work. He received very unexpectedly, about three years since, a notice from the officer of the household of the President of the Republic, to the effect that he would be received next day at the Elysée Bourbon at a certain hour; he duly attended, and was soon ushered into the Cabinet of the Chief of the State, by whom he was received most courteously. "It appears to me," said Louis Napoleon, "that the Palace of the Louvre should no longer remain in a condition which reflects disgrace on the government, and it is desirable that employment should be provided for the working classes; I have therefore conceived the design for the completion of this palace, which I wish you to undertake." "Sir," replied Visconti, "I am gratified by so honourable a mark of your confidence, but I venture to remind you that M. Duban is architect of the Louvre, and it is impossible for me to interfere with a position which he fills with so much credit and ability." True," replied the President, "but M. Duban is architect of the works of the Old Louvre; I wish you to undertake this appointment as architect of the works of the New Louvre, which are to be quite distinct, and to be a charge entirely separate, and not interfering with or superseding the other." "In that case," said M. Visconti, "I am quite at your command." The Prince then explained a scheme that he had himself conceived and roughly sketched, which he wished Visconti to draw out architecturally, and asked how much time would be required. When informed a month, he said, "Well, in a month I shall expect you to come, and you shall be admitted at once."

At the end of that time, Mons. Visconti took the plans, and submitted them to the President, who highly approved of the manner in which his views had been carried out. Mons. Visconti than ventured to suggest, that in the course of study to which the plans had given rise, it had occurred to him that a much nobler and more desirable arrangement could be adopted, which he should wish to submit to his Highness's approval. The Prince immediately encouraged the architect to develope his views, and this he did in his succinct, clear, and convincing manner, so as to carry the conviction of the President, who then asked him how much time he would require to prepare the necessary drawings. Six weeks. "Enough," said L. Napoleon, "and in six weeks bring me your project thoroughly considered." Accordingly, in six weeks Visconti again attended at the Elysée Bourbon; but during the interval the Republic had become an Empire, and the President Emperor. It was sufficient for Louis Napoleon to see the design which his architect had prepared; his ready aptitude seized all the superiority of the arrangements proposed, and he expressed himself perfectly satisfied. Taking out a paper from his breast-pocket, he presented it to Visconti, saying, "Take this document, it constitutes you architect of the new works of the Louvre." In fact it proved to be a formal document, signed by the proper authorities. The Emperor desired him to be ready to attend a council in a few days, and explain the plan, and to be prepared with general estimates as to the cost. Our architect, of course, was punctual to the appointment, and while awaiting the meeting of the council engaged in conversation with several of the members. Being anxious to ascertain their sentiments, he asked their opinion: one thought it a very fine design; another, that it must cost a great deal of money; but none would venture to pronounce that it was a desirable and executable project. At length the council met, and the most vehement objections were taken to the idea; the principal one being, to its vast cost. At length the chief minister said, "It is the wish of the Emperor." These words at once calmed the storm, like oil poured upon the waves; not a dissentient was heard; many raised their voices in praise of the noble conception of the Emperor, and the immense talent of the architect; and the requisite millions no longer forming any obstacle, the design was approved, and ordered for execution, with the necessary funds.

I do not at the moment call to mind any very large public building that Mons. Visconti has erected at Paris; but the monument of Molière in the Rue Richelieu; the fountain on the site of the old Opera Place Louvois; the noble fountain of the Place S. Sulpice with the sedent statues of the four great Doctors of the Gallican church; a fine façade at the angle of two streets in the Rue Neuve des Petits Champs; and lastly, the tomb of the Emperor Napoleon under the Dome of the Invalides, attest the fertile imagination, originality, knowledge, and taste of Visconti, and doubtless contributed to indicate to Louis Napoleon one capable of realising the noblest projects in his art.

In October last I experienced many marked attentions from our colleague, due doubtless to the position I hold among you as your Foreign Secretary. He received me at his house, and I must own that his reception-rooms displayed refinement and elegance superior to any other private residence in Paris. The furniture was of a superb description, and full-sized cheffonnieres of black ebony with glazed fronts contained most exquisite enamels of various sizes, dishes and vases of Raphael and Lucca della Robbia ware, or china of the revival; there were fine bronzes and choice pictures: in fact, one seemed to breathe an atmosphere of art, evidencing the host a man of refined taste, and one who possessed a perfect discriminating relish for all the arts.

He was heir to a great European name, one of a family distinguished for archæological learning, and has nobly maintained the reputation of his ancestors. His personal presence did not seem to indicate the noble qualities within him; but his exalted genius, his simple, unaffected manners, his cordial address, his loyal and generous sentiments, were the confidence, the esteem, and admiration of all who were admitted to his friendship. I need hardly say how highly he valued the gratifying compliment paid him by this Institute in electing him an honorary member. He entrusted me for presentation with a copy of the work showing his design for the completion of the Louvre, inscribed with his own hand, and, at my request, has sent you full-sized drawings of certain iron girders for the floors, one of 70 feet span, which he purposed employing. At some future time I may perhaps give a history of the Louvre and Tuilleries, note the various projects for their union, describe that of our lamented colleague, and explain some points of ingenious construction in the floors.

On the 4th ult. his remains were deposited in Père la Chaise, followed by one of the carriages of the Emperor, and attended by many ministers of State and noble functionaries, the leading men in science, literature, and the fine arts; his pall borne by the most distinguished men in France, and accompanied by the tears and regrets of several hundred workmen, who felt that they had lost indeed a noble leader. The long line of streets which led to the cemetery abounded with testimonies of respect to the memory of this great man. And a minister of State, the perpetual Secretary of the Academy of Fine Arts, our colleague, Mons. Caristie, Mons. Rohault de Fleury, and Mons. le Baron Paul de Richemont successively addressed the thousands assembled, as did also our Honorary and Corresponding Member, M. Hittorff, from whose touching discourse I borrow a few sentences, which seem penetrated with a due appreciation of the character of his colleague and friend.

"The loss," said M. Hittorff, "of an artist, who united the highest faculties of the mind to the no less noble qualities of the heart, is afflicting to those who were privileged to possess the opportunities of appreciating in him those high natural gifts. But when, as now, this artist is carried off in the midst of the most important works, at the moment when he might naturally look forward—as we all might—to their happy completion and glorious success, this loss is no longer a mere family bereavement, it is a public calamity. Certainly, in the immense and grandiose work which fell to the lot of Visconti, it required, in addition to the conception of the architect, a rare combination of circumstances to carry up, in less than two years, that which had occupied nearly half a century under the greatest of our kings; it required still more to know how, as did our friend, by incessant activity—by a rapid *coup d'œil*—by a discernment as prompt as just, to render available all those precious elements, and to organise an army, as it were, of able and intelligent assistants and artificers to carry out the work.

"The head of the State was doubtless glad to connect his name with the completion of the finest palace in the world, and still more to recall by such a work, minds which had too long been led astray; nor did the architect peril his fair fame in this surprising rapidity of execution, which astonished all Paris, and excited the wonder of those foreigners who flocked hither. M. Visconti bestowed the utmost care upon the soundness of the construction, as upon the exquisite beauty of the design. These incessant occupations and flattering combination of circumstances did not at all alter the natural character of our friend. Although naturally aware of his own capacity, surrounded by numerous gifts of fortune, raised to the enviable position of architect to his Emperor, Member of the Institute of France, President of the Central Society of Architects, nothing altered the constant amenity of his character; he was still the same unaffected, modest man, always ready to oblige, and ever disposed to recognise the merit of others."

To such an eulogium it is unnecessary for me to add one word; but, in conclusion, I beg to notice an inadvertant expression which escaped M. Rohault de Fleury in his address; it is contained in these words: *"It has been said with just reason that the loss of Mons. Visconti is irreparable."* To his family and friends such a bereavement is irreparable; but you and I, gentlemen, must feel, that however great this loss may be to architecture, it cannot be irreparable to France, when she possesses so many men of such distinguished tastes to uphold the high rank which she has attained in the commonwealth of the arts.

## SYSTEM OF RAILWAY TRACTION DURING SNOW.

During the late severe weather the apparition of sledges in the streets must have suggested how easily iron glides over a smooth surface; and the exercise of skating, during which a man with little muscular exertion glides over a very considerable space, is another proof of the same fact. According to the present system, steam-engines could not draw a train along rails coated with ice, or covered with snow, were not gravel continually dropped between the two surfaces of the wheel and the rail. Such an expedient as this cannot evidently be adopted as the definitive mode of remedying the evil alluded to.

But the absence of the natural friction between the wheels and the rails is not the only obstacle presented by the snow. The greatest difficulty arises from the accumulation of the snow on the railway, which obstruction the engine cannot overcome, paralysed as it is from the above-mentioned absence of friction. To meet the difficulty it would scarcely be sufficient to provide the engine with irons acting like ploughshares, for the purpose of clearing the way as a plough opens a furrow; for this exceptional service the present engine will only have its usual power, and from this must be subtracted the loss of friction occasioned by the snow or ice, and this friction, be it remembered, results from the weight of the engine alone.

M. Léguier has proposed a system which he thinks will have the desired result, with the additional advantage of relieving the ordinary rails of the excess of weight which a steam-engine presents over other vehicles.

His project consists in a third rail placed between the other two, and especially destined for traction. The motive-wheels would be replaced by smaller ones, working opposite each other in the same horizontal plane, and having between them the middle rail, on which they would act by turning like the rollers of a flatting-machine (*laminoir*).

It is possible, in fact, to construct a special machine, with large pistons, long moving bars (*manivelles*) and very small rollers. The power of such an engine, provided with suitable means for piercing the snow and throwing it on the sides of the railway, would only be limited by the surface of the pistons, and the solidity of the rail on which the rollers would work. However, for the purpose of clearing the line, speed might be sacrificed, and it is probable that a machine of ordinary dimensions, provided with rollers of small diameter, would possess sufficient power to struggle against an accumulation of snow.

M. Léguier, in submitting his plans to the French Academy of Sciences, stated the principal advantages inherent to the system of traction proposed, which would admit of the engine being divided into two distinct parts, thus relieving the ordinary rails, and facilitating the action of the machinery and generator, isolated one from the other.

[The novelty and advantages of M. Léguier's system of traction might be more apparent, were the description more intelligible. His method of dividing the engine into two parts is at present inexplicable. The idea, however, may give rise to some more valuable suggestions, when it is understood. Ed.]

## PERPETUAL VENTILATION OF THE GREAT PYRAMID OF EGYPT.

By G. W. Smith.*

This method of solar ventilation, which has so recently been applied in the United States, is nevertheless the most ancient in existence; having been applied at least 4000 years ago in that most venerable monument of Egypt, the great pyramid of Cheops (Khoufou or Suphis). In the first volume of Vyse on the pyramids of Gizeh, a description is given by Colonel Vyse, of the operations for removing the obstructions from two narrow apertures or tunnels, which ascend from the great chamber near the centre of the pyramid to the surface in an inclined direction. These had long been conjectured to be ventilators, and when the rubbish had been removed from them, the previous conjectures proved to be correct. The suffocating mephitic air of this, the King's chamber, was immediately changed by a rush of pure air from without.

The manner by which these air channels acted when the present entrance passages were closed, has not hitherto been explained, Mr. Smith stated, by any writer on these monuments. As the mode of action is extremely simple and efficient, and the very durable apparatus entirely self-acting, requiring no attention whatever, being moreover in as perfect a condition as on the remote day when it was finished, 120 generations ago, it deserves our attention. An inspection of the accompanying diagram will

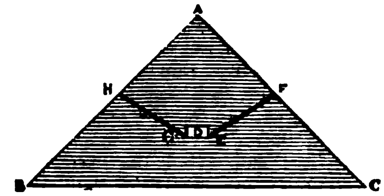



exhibit the plan at a glance. A, B, C, shows the pyramid in section (the closed passages are not represented); D, the King's chamber; E, F, the north air channel; G, H, the south air channel, which being more heated from the sun's rays striking on the south side of the mass A, B, the air will be heated, and thus rarified will rise in it by the pressure of the dense column in the northern or cooler side of the pyramid, day and night for ever.

During the process of building the chamber, and until the external casing of the pyramid was added, it cannot be doubted that the action would be perfect; but even when cased, the joints would not be perfectly air-tight, and therefore would permit some circulation of air.

Recently, in Philadelphia, advantage had been taken of certain brick walls containing flues; the walls being heated by the sun to which they were exposed, rarified the air in the flues which communicated at their lower portions with the apartments to be ventilated, and the plan has been found, even with thin walls, quite effectual, and was strongly recommended for adoption in many places where it might be applicable.

## BUILDING IN BIRMINGHAM.

The returns which have been published, under the Birmingham Improvement Act, exhibit, in a remarkable manner, the expansion of the town—the consequence of its great manufacturing and commercial activity. During the last 40 years of the century the average increase was 608 houses; for the last three years ending 1851, the increase of houses was about 800 per year. The last two years, however, exhibit a far more extraordinary and gratifying character. For the 15 months ending March last year the increase in houses was 3020. The last year, taken altogether, from the 1st of January to the 31st of December 1853, shows an increase of 2784 houses, exclusive of warehouses, manufactories, and multitudes of other buildings springing up on every side, and invading the agricultural precincts of Warwickshire, Worcestershire, and Staffordshire. If these were to be comprised, 1000 more might be added to the number already given.

* Paper read before the Franklin Institute, U. S.

## ORDNANCE SURVEY OF SCOTLAND.

As the subject of correct surveys in connection with sanitary and other improvements, and more especially the long-promised survey of Scotland, has been very prominently under the consideration of government for the last few years, and as every information on the subject must be highly interesting to the profession generally, we have in a former number reviewed and made extensive extracts from 'Letters upon the Survey of Scotland, by a Practical Surveyor.' We considered that the subject was treated fairly and practically in these Letters, and that they contained many practical hints which might be turned to good account in a national as well as in a professional point of view.

We have understood, however, that some of the Ordnance Survey authorities have complained that they were treated rather harshly in these Letters; but as public men, conducting a purely civil operation, and at a very great expense to the country, they ought not, in this age of progress and inquiry, place themselves beyond the reach of fair, legitimate criticism; and as we find it extremely difficult to obtain reliable information upon the manner in which these great and important national works are conducted, or to arrive at the cost of any specific operation, we are therefore happy to lay hold of the materials within our reach.

Our columns are however open to the military as well as to the civil surveyor; and as we are thoroughly convinced that publicity and a searching but fair criticism are the main safeguards of all our public departments, we see no reason why the military surveyors should be so fastidious as to consider everything which is said about the important public duties in which they are engaged, as so much personal insult offered to themselves.

This sensitive feeling must be the result of their military education, of the high-caste system which they assume and endeavour to perpetuate by the impassable barrier which they place between themselves and the operatives, or rather machines (*a la* Yolland), which they employ, and upon which the execution of the whole of their operations must necessarily depend. If civil engineers were as much annoyed at the fair criticism of their various works as military engineers appear to be, they would be deprived of many valuable hints which at present they frequently turn to very good account in the improvement of their subsequent operations; which is much better than to stand still in an age of gigantic and rapid improvement.

Those who are acquainted with the progress of science in England must be aware, that when the survey of Ireland was commenced in 1824, the details of extensive surveys were but very imperfectly understood, and it would have been no disparagement to the conductors of that extensive operation if they had commenced by experimenting upon the best mode of conducting so complex an operation, and not to have proceeded further than mere experiment until the Commissioner of Valuation had ascertained correctly and stated explicitly what documents he required to be supplied with, and the degree of accuracy, which was indispensable; but instead of this, Col. Colby, who could have had no previous knowledge of extensive detailed surveys, states, in his letter of the 6th May, 1840, that he "commenced the task by drawing up a code of instructions."

What would be thought of George Stephenson if, before he had constructed the first railway in England, he had "commenced the task by drawing up a code of instructions," which should be binding upon the profession for all time to come? Had this been the case, the very important improvements in bridges, viaducts, and other important works connected with railways and railway machinery, could not have been effected. This subordinate action produces a paralysing influence upon the mind, the very essence of which is freedom of action, and without which its varied powers can never be developed. Progress is unquestionably the supreme law of the soul; but without the freedom of thought and action, this progress cannot take place.

As the papers which are being prepared by the Treasury, and which will no doubt contain the final decision of the government upon the long-contested question of the scales at which the national surveys shall for the future be constructed, are not yet before the public, we will at present simply advert to a few of the most prominent and most important points contained in the Report of the Select Committee on the Ordnance Survey of Scotland, and the correspondence between the Treasury and the Ordnance in reference to the recommendations contained in the above report, ordered by the House of Commons to be printed, 22nd June, 1852.

The above report, like all other "Blue-Books," contains much valuable information, with an immense mass of mere twaddle. Select committees, particularly on scientific subjects, appear to be at a very great loss in not being able properly to shape their questions so as to elicit the truth from a reluctant witness, or a witness who is determined to support certain preconceived views and opinions. Another hindrance to the production of a clear consecutive train of evidence, and a cause of much embarrassment to a witness, is the mode of examination pursued by the committee. One member, probably the chairman, may take a witness consecutively through the greater part of the subject under investigation with tolerable success, but upon the slightest pause being made in the proceedings, another member chimes in, and asks a question probably unconnected with the subject altogether, or a question that had been previously answered over and over again, and quite out of the former line of examination.

Honourable members are frequently placed upon a committee in consequence of entertaining antagonistic opinions upon the subject about to be investigated. This circumstance, not unfrequently and not unnaturally, results in the highly objectionable practice of leading questions being very much indulged in. In some cases, one would suppose that the committee were composed of two batches of hostile lawyers, endeavouring to make the *most* and the *least* of each witness who came before them, and acting without the control of a presiding judge.

Much has been said by several witnesses respecting the applicability of the 6-inch map of Ireland for parliamentary deposit in the case of railway bills. The advocates of the Ordnance 6-inch maps have very much exaggerated their utility for railway purposes, and probably they have been somewhat depreciated by other witnesses.

It is well known to railway engineers and surveyors, that the most imperfect, rubbishy plans and sections of proposed railways will, if *unopposed*, pass a Committee on Standing Orders without any objections being made to them; and we do not recollect a single instance in which there has been a well-contested opposition to an Irish railway bill on Standing Orders. By an opposition on Standing Orders, plans, and more particularly sections, are rigorously tested; but as respects plans, the allegations that can be sustained on Standing Orders are more technical than real. For example, the Standing Orders require that every field or inclosure shall appear on the map, and be described by a reference number, but a field containing twenty acres in area may be delineated on the map of the same size as a field containing half that area, and no allegation upon the subject could be sustained; so that even to pass Standing Orders against a strong opposition would be no proof of the accuracy of the map for valuation and other important purposes.

It must also be observed, that 6 inches to a mile is not a sufficiently large scale to obviate the necessity of supplemental plans on a larger scale, as the Standing Orders require that "an enlarged plan shall be added of any building-yard, courtyard, or land within the curtilage of any building, or of any ground cultivated as a garden, either in the line of the proposed work or included within the limits of the said deviation, upon a scale of not less than a ¼-inch to every 100 feet."

In a densely-populated country, where the tenements are small and the houses and cottages numerous, these supplemental maps would embrace a very considerable extent of the whole line of railway, and as they must be engraved or lithographed, the time and expense saved by the use of the 6-inch Ordnance maps would be very inconsiderable.

The 6-inch Ordnance sheets, with section and enlarged plans detached, make a very inconvenient mass of documents to refer to; and in carrying an opposed bill through parliament, forty or fifty copies would be required for engineers, land valuers, solicitors, counsel, &c., it is therefore found to be more convenient, if not less expensive, to have the whole plan lithographed, upon a scale which would not require additional enlarged plans.

The great stress which has been laid upon the applicability of the Ordnance 6-inch map of Ireland to railway purposes affords another strong proof of the great length to which puffing can be carried in the present speculative age.

The question has frequently been asked by the committee, whether the survey could not be "drawn in the books of the Ordnance on the 6-inch scale" for future reference, and only published on the 1-inch scale? These questions were put and answered in such a manner as to convey a very confused impression of what was really meant by the committee or their witnesses. The committee appear to confound the survey made in the field—that is, the results of the various measurements made on the ground and entered in a book—with the operation of transferring those measurements to paper, so as to construct a map or plan, which map or plan may be constructed on any required scale; but the field-notes, abstractedly considered, can have no reference to scale. It is true, that in taking field-notes for a map to be constructed on a scale of 1 inch to a mile, those objects only would be surveyed and entered in the field-notes which could be drawn upon a map of the required scale; and the larger the scale at which the map is to be drawn, the more accurately should the measurements be made on the ground, and the greater the number of objects would be inserted in the field-notes.

If the committee had an idea that the field-notes could embrace all the detail which is generally shown upon a 6-*inch* map, and only those portions of the notes laid down upon paper which it would be desirable to exhibit upon a 1-*inch* map, reserving the great mass of detail to be laid down on the 6-inch at some future period: nothing can be more fallacious. It is quite bad enough at present, when one man is measuring lines in Glentilt or Glenmore, or some of the mountain districts of Scotland, and another man, who has probably never stretched a chain in his life, laying down the work in Southampton.

The confused notions which the committee appear to have had on this subject is not in itself of much importance, but it allowed them to be led astray when the subject of the Admiralty Coast Surveys came to be discussed, and it afforded the advocates of the 6-inch scale an unfair advantage in the investigation.

Can any unprejudiced person, at all acquainted with the subject, carefully read over paragraphs 1429 to 1451, and 1458 of Captain Yolland's evidence upon the subject of Admiralty charts, without arriving at the conclusion that these paragraphs exhibit an admirable specimen of what lawyers call "fencing?"

Such is generally the result, even with the most honourable men, when determined to advocate, at all hazards, any preconceived opinions. Take for example:

1429. "The *one-inch* map of the western coast of Scotland would not be sufficient to enable the Admiralty surveyors to put in their coast line from it."

1437. "With regard to the coast, what is the scale the Admiralty are going on?"—"I think *under half-an-inch* to a mile."

1438. "Would not the scale of two inches to a mile be sufficient for all the purposes of an Admiralty chart; and might they not survey the harbours on the large scale in the same way as you survey the towns upon the large scale?"—"*Practically, not.*"

1444. "Do you know the scale to which they make their maps as to the soundings in the inland navigations?"—"They are stated to vary from *three* to *twelve inches a mile.*"

1445. "Would your six-inch survey do away with the necessity of the Admiralty making a further survey?"—"An accurate six-inch survey, if enlarged to a scale of twelve inches to a mile, would be more accurate than any nautical surveyor can survey it, with the means at his disposal."

1446. "If an accurate map, drawn to a *six-inch* scale could be enlarged to *twelve inches*, would there be any difficulty in enlarging a *two-inch* map to a *four-inch*?"—"The nature of the survey for a two-inch scale and a six-inch scale are essentially different."

This answer is a mere evasion of a very plain and pointed question. If an acute lawyer had the handling of a witness of this description, he would soon impale him upon the horns of a dilemma, from which he would not very easily nor very honourably extricate himself.

1470. *Answer.*—"If a one-inch map of Scotland alone were required, I think it might be made with the accuracy that that scale admits of—probably at one-third of the other; *but that will involve the throwing overboard of the surveys of all large towns;* because the triangulation that suffices for a survey of two inches to a mile will be entirely insufficient for a survey of a scale of sixty inches to a mile, or even the *supplying of points* if they were asked for by the Admiralty surveyor."

This is not simply fencing in favour of the six-inch map, but it is absolutely contrary to the facts of the case, and calculated to mislead the committee, whether intentionally or not we do not pretend to say; we would be sorry to suppose it was, but most assuredly the government have a right to better treatment from their own witnesses. As Capt. Yolland states to the committee that he is the "executive officer at the head-quarter office at Southampton," we must charitably suppose that he is well acquainted with the whole *modus operandi* of the survey, and well qualified to direct the committee in their important investigation. He might therefore have said, and with great truth, that to give up the *six-inch* scale and to adopt the *one-inch* scale for the survey of Scotland, will *not* involve the throwing overboard of the surveys of all *or of any* large towns, nor will it throw any impediment in our way in supplying any number of points to the Admiralty surveyors. To come from the six-inch, or from the one-inch to the five or the ten feet to the mile, is only a matter of degree, and involves no more difficulty in the one case than in the other; for in surveying the rural districts on the six-inch or any other scale we adapt the number of fixed trigonometrical points to the amount of detail to be surveyed. In an open mountainous district, the fixed points may be two or three miles apart, but in a closely-cultivated district they will only be about one mile from each other. And with respect to towns, we simply increase the number of points in the same way, and with very little additional trouble, from this circumstance: that in a town there are a great number of natural objects, as church-spires, towers, turrets, flag-staffs, factory chimneys, &c.; and an observer perched upon the top of a mountain in the neighbourhood of a town can never prevail upon himself, when sweeping his telescope round the horizon, to pass over a well-defined, permanent object without recording its bearing. We doubtless require the points to be more numerous in a town than in the open country, but this would be the case if the survey of the town was to be laid down on the same scale as the surrounding country.

And in reference to the Admiralty, we can very easily, without much additional trouble or expense to the Ordnance, give the Admiralty surveyors much more assistance than we have ever given them before. We can request the Hydrographer to the Admiralty to furnish the Ordnance with a statement of the scales at which he will require the coast-line to be constructed, and also the several inland navigations in connection with the whole kingdom: we will then increase the number of points in those portions where a large scale is required, and also give directions to the field surveyor to make more minute measurements of those portions; and this will enable us to supply the Admiralty with plotted plans for the basis of their important operations, which will be superior to reductions or enlargements.

We are aware that at present the Admiralty surveyors labour under very great disadvantages in consequence of being in advance of the Ordnance; indeed, they are thrown almost as much upon their own resources with respect to the Coast Survey of Scotland as if they were surveying the coast of New Zealand or the Feejee Islands, and that no efficient body of Ordnance surveyors existed.

This we can very easily remedy, irrespective of the pending question of scale, as we have our primary triangulation completed for the whole kingdom. We can produce a survey of the whole of the coast line at probably one-tenth of the expense at which the Admiralty surveyor can execute the same work much more imperfectly; and as we *really* belong to the same government, and that both departments are paid out of the same taxes, perhaps this might be a good practical view to take of the subject.

We will say no more about the Report on the Scotch survey at present, as we will have to advert to it again in connection with contouring, and probably the valuation of land. But *apropos*, can any of our numerous scientific readers inform us what has become of Captain Yolland?—he appeared to be the great gun at the time of the sitting of the Committee. Is it possible that he was stepping in front of his chief; or has he committed the unpardonable sin of knowing more about the matter than those above him in the graduated scale of rank, which also regulates the graduated scale of knowledge? It appears, at all events, that he is *non est*, as far as the recent investigations are concerned.

The result of the deliberations of the Committee has long been before the public:

1. " That the six-inch scale be abandoned.
2. " That the system of contouring be abandoned.
3. " That the survey and plotting on the two-inch scale be proceeded with as rapidly as is consistent with accuracy, with a view to the publication within ten years of a one-inch map, shaded and engraved in a manner similar to the Ordnance one-inch map of England, with as many elevations as possible given in figures.
4. " That the survey be proceeded with steadily from south to north, as was the original intention."

The communication of the above decision of the Select Committee to the Ordnance threw the survey authorities into consternation, well knowing that as the present generation of Ordnance surveyors have been mechanically instructed in the several distinct operations into which the execution of the six-inch survey is divided, a more intellectual class of individuals must of necessity be sought for to execute with rapidity and accuracy an artistically finished one-inch map of Scotland.

This crisis of the affair produced a letter from Colonel Hall, in which the most remarkable feature is an allusion to Lord Langdale's letter of the 30th November 1848, in which his lordship enumerates various uses to which accurate maps on a large scale can be applied; such for example, as the purposes of "the *poor-law tithe commutation, parochial assessments, sanitary purposes*, the *registration of deeds*, or assurances of land, show only some of the many great and important purposes for which good and accurate public maps are required."

Colonel Hall must have been aware that the six-inch map is altogether inapplicable to the various purposes which Lord Langdale enumerates, and that they can only be carried out by an accurate map constructed on a scale of twenty-five or twenty-six inches to a mile. Colonel Hall may, no doubt, have been led astray by the Commissioner of Valuation in Ireland, attempting the gross absurdity of making a tenement valuation upon the imperfect data supplied by a six-inch map.

The opinions of civil engineers upon the decision of the Select Committee were also solicited by the survey authorities, but as the letters requesting those opinions are not given in the correspondence we have no means of ascertaining how the proposition was put. The answers would appear to imply that the question was as between the six-inch and the one-inch, and not between the six-inch and a larger and a more efficient scale.

We are, however, very much surprised to find Mr. Vignoles so uncompromising an advocate for contouring, as we are aware that in the selection of a line of railway (in which operation we consider him second to no engineer of the day) he employs a very efficient system of surface levels, which, in his own practice at least, he evidently prefers. It is very true this gentleman was writing in "great haste," as he was taking his "departure for Russia to meet the *Emperor* and the *Minister of Public Works*." He had also some business to transact with "the great eclipse of the sun on the central line of shadow at Ooman." These and many other important matters contained in the letter, and not bearing very directly upon the *one-inch* or the *six-inch* scales, must, to any reasonable critic, be a sufficient apology for any apparent discrepancy between practice and theory.

## ON RAILWAY TURNTABLES.

By SAMUEL LLOYD, Jun., of Wednesbury.

[*Paper read at the Institution of Mechanical Engineers.*]

IN the construction of turntables, three leading principles have been followed; either the bearing has been on the centre only, with no bearings at the circumference, or with bearings at the circumference and none at the centre; or a combination of these two modes has been adopted by allowing the weight to rest in part upon the centre, and in part upon the bearings or rollers at the circumference; this last construction has been most frequently adopted. Most of the turntables first laid down on railways were made to rest on fixed rollers, for the sake of economy; but although fixed-roller turntables are the cheapest kind in first cost, and were much used on the first railways made, live-roller tables have been generally adopted latterly, from the greater ease with which they turn;—as in the fixed-roller turntable the weight bears on the axle of the roller, producing rubbing friction, but in the live-roller table it bears upon the circumference of the roller, producing only a rolling action without any rubbing friction except in the guiding ring. Some fixed-roller turntables have however of late been constructed with much larger rollers than those formerly used, which has the effect of perceptibly lessening the friction; but these tables seldom continue long in good working order, in consequence of the rollers *indenting* the top table. This is an objection to which all roller turntables are subject, but those with fixed rollers most especially, from the top table always resting upon the rollers in these, in the same position, thus receiving the pressure always on the same points; and as the amount of surface in contact between them is very small (the whole amount of surface in contact between the surface of the rollers and the top table being not more than three square inches, if so much), the rollers soon wound the under surface of the top table, so that the latter becomes indented over every roller. As soon as this takes place, considerably more power has to be exerted to turn carriages upon them, as the resistance to be overcome is greatly increased by the whole weight having to be lifted out of each of the hollows formed from the above cause.

But in addition to the increase of friction occasioned by these indentations, they cause also great unsteadiness, making the table rock, and thus clatter and hammer against the rollers as each pair of wheels passes on and off its two opposite sides. This deteriorating action goes on to a greater or less extent in almost all roller tables, often occasioning the top to break, if it is not very strongly made; this rocking is often greatly increased, and occasionally entirely originates from the centre being too tightly screwed down, so as to take the weight entirely off the rollers on one side of the table.

This defect has led to the construction of turntables with a centre pin that acts merely as a centre guide, without taking any weight. Turntables of this class, if made with radiating rollers, have the advantage of remaining very solid for a time after they are put in, but frequently this is not of long continuance, for all roller turntables are unsteady, if the rollers are not *all* correctly turned to the same diameter, and cottered or screwed up exactly to the same distance from the centre; each roller being a portion of a cone, its outside diameter is greater than its inside, and if either of the rollers is screwed up too tightly, the table rides on it. This is sometimes occasioned after a few months' wear, by the pressure of the table top continually exerting a force tending to drive the rollers upon which it rests outwards, which is sure to be the effect if either of the nuts that screw them becomes slack. This pressure tending to force the rollers off the roller-path, causes considerable friction against the guide-ring at the boss of every roller, and is one cause of the heaviness with which even live-roller turntables work, causing railway labourers in goods stations, whenever they have the chance, to wrench them round by horse-power.

In an improved construction of roller turntables extensively adopted, the weight of the table top is nearly counterbalanced by a weighted lever which constantly tends to lift the centre pin without actually doing so, making the table much easier to turn, by diminishing proportionately the pressure on the rollers; the rollers also are not fixed as in common turntables, but in an inclined position, with their upper surfaces level, for the purpose of preventing the level of the table top from being disturbed by the surge of carriages passing over. In some turntables the rollers have been made with rounded edges and level roller-paths, with the view of lessening the friction of turning, and increasing the steadiness of the table by resting it on a plane instead of a cone; but these rollers have not been found to be durable, and the roller-path becomes worn hollow by them. A more successful plan for diminishing the friction has been the use of spherical balls instead of rollers, travelling round in a live ring, to prevent the balls from rolling off, but allowing them room to shift their position on the roller-path as they move round, which prevents them from wearing the roller-path into grooves; and as the balls travel in a circle, sometimes in one direction and sometimes in the contrary direction, they continually present a fresh portion of their surface for the bearing, which preserves them from being worn unequally.

There is one objection to these tables, but which applies still more strongly to roller turntables—namely, the extreme difficulty of turning them in frosty weather, when the dirt on the rollers and roller-paths becomes frozen; horse-power is then often required to stir them, or a fire has to be lighted to thaw the congealed mud collected on them.

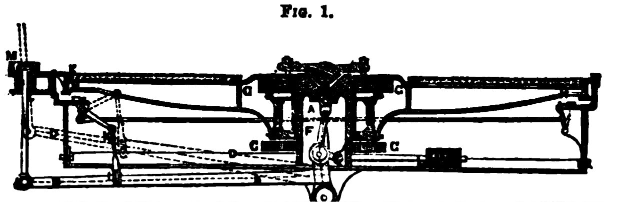
*Centre-bearing turntables* are practically free from this objection, and also from the one before referred to—namely, the bearing surface becoming indented, from the small extent of surface in contact with the rollers.

They also, as usually constructed, have most of them two defects—namely, great extra cost of foundations, and unsteadiness and liability to deflect; the last being the most serious defect, which renders them objectionable for any situation where much traffic is likely to pass over them. Their deflection upon trains passing over them being caused by the whole of the weight of each carriage acting at a great leverage to strain the working parts of the table while running on and off.

The *unsteadiness* of the centre-bearing turntables described above may be considered as the principal cause of their disuse, notwithstanding their superiority over roller-tables in ease of turning; another cause being the expense and depth of the foundations requisite.

Figs. 1 and 2 show an improved mode of constructing turntables, by which the result is obtained of supporting the table top by its circumference when out of use, and upon its centre when in use. The action of the lever B, B, in this table is to raise the table sufficiently to disengage the blocks H, H. When the table is not in use the lever is in the position shown at B, B, but as soon as it is necessary to turn a carriage, the table top is eased off the four blocks H, H, at the circumference, under the main-line rails, by being raised from $\frac{1}{4}$-inch to $\frac{3}{8}$-inch by the action of the knuckle-joint lever F; by this time the stud I, which is fixed upon the long lever B, B, having traversed to the end of the slot in which it works, carries the rod K, with it; thus withdrawing the four blocks HH, from under the outer ring E, E.

Fig. 1.



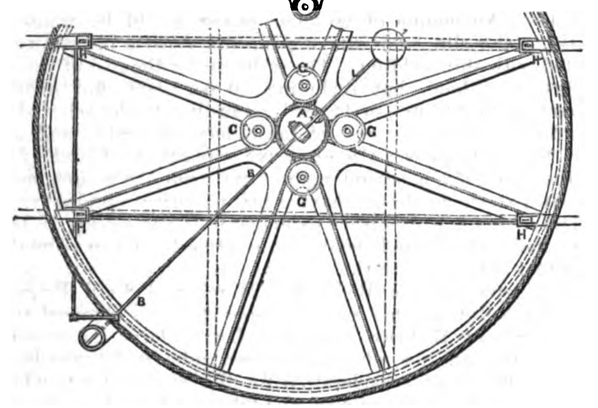


Fig. 2.

The long lever is now at the position shown in the drawing, or at the bottom of its stroke; the centre joint of the knuckle-joint lever F, has now passed from one side of the centre line of the table to the other. The table top is exactly at the same level when the long lever is at the bottom of its throw as when it is at its top; the difference being that when the long lever is up as shown by the dotted lines D, D, the table top is supported entirely at its circumference on the four blocks, which may be made of any convenient size; and while it is down the weight is on the centre pin C, when carriages may be turned with ease and rapidity. By means of the stud I, traversing the slot in the rod K, during the first part of the motion, the table top is eased off the bearing on the blocks H, H, before the rod K, is set in motion to withdraw the blocks; and by the same means, in lowering the table, time is allowed for the blocks to be pushed home before the table top is lowered upon them, so that the blocks are relieved from the weight whilst they are being moved. Fig. 2 is a plan of this turntable, showing the position of the long lever B, B, and the horizontal rollers G, G, that work round the centre pillar A. At the end of the lever L, a weight is fixed to balance the weight of the table top to within a few cwts.; the balance weight not being made heavy enough to raise the table top without the exertion of a slight pressure on the handle M. Other modifications of this improved table might be described, but as the principle in them all is the same, viz., to carry the weight on the centre pin when the table is being used, and upon the circumference when not in use, it is not necessary in the present paper to do so.

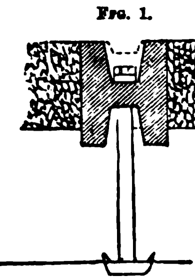
This mode of construction insures a *solid turntable*, one very *easy to turn*, and a very *durable* one; the working parts do not get deteriorated by the passing of trains, and are so placed that dirt cannot collect upon them; the extent of bearing surface at the circumference is greatly increased, and prevented from becoming indented as in roller tables; a smooth and easy motion is obtained by turning entirely upon the centre, as no inequality of bearing surface has to be overcome; also less oil is consumed for the centre bearing than for rollers, and the working parts are more easily oiled. In roller tables an increased load increases greatly the resistance to turning, and after some years wear they work more heavily; but in centre bearing tables much less difference is experienced. Also, the cost of foundation, instead of being more, is rather less than that required for roller turntables with a live ring and rollers, as a continuous ring of masonry is not required round the circumference, but only six or eight blocks of stone, one under each arm of the centre pillar, in addition to the centre stone, which is required in both descriptions of turntables.

## STREET OR HIGHWAY RAILWAYS.

William Bridges Adams, C.E., *Inventor*.

Our engraving fig. 1 shows a "channel" rail especially adapted for street or highway lines where other vehicles are intended to run. It is shown as intended to reverse. The form is that of the letter H. The horizontal web which connects the two vertical sides together is formed with holes, through which pass bolts or screws to fasten it to the transverse, or horizontal sleeper, into which it is slightly grooved to secure the gauge. For street and road work it is required that the paving should come close up to the rail to secure it, and preserve the level. Consequently, the flange of the wheel must run between, and it can be either a central or side flange, according as the wheel may be required to sustain a heavier or lighter load. This rail may be made with a single channel if preferred, but with a double channel it is capable of four reversals if used with light loads. Made with a single channel it would be about 70 lb. per yard. Double, it would be about 95 lb. per yard. It must be borne in mind that rails exposed to be run over by heavy road-carts and wagons would require to be more firmly fixed than such as are protected from lateral blows. The joints are made by an iron casting, or a piece of the same rail, bolted beneath or laterally. Instead of timber sleepers stone may be used, and the sleepers may be either transverse or longitudinal. If stone sleepers be used elastic material should be placed beneath the rails.

Fig. 1. Fig. 2.



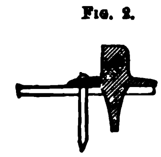


Fig. 2 explains a system of moveable rails of the form best adapted to give strength with the lightest weight of metal laterally and vertically. The rails might be made of angle-iron, with the corner upwards; but more metal would be needed, as a weight would spread it out. The rails are each about 18 lb. per yard, and they are connected at the joints by a flat cross bar, to which they are notched, while a forked staple holds them end to end, holes being pierced in the horizontal web at the rail ends at different distances, so that by using one set of holes a straight line is formed, and by the other set a curved line.

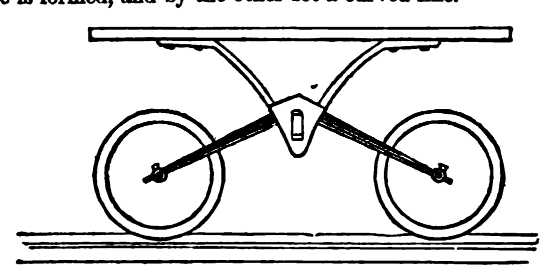


Fig. 3.

Fig. 3 shows a light spring wagon, such as should be used on these rails. The importance of flexible springs cannot be too highly estimated; not merely for lightness of draught, but for the saving the rails and wagon from destruction, and for enabling the wheels to press equally over rails out of level by reason of rough ground. This wagon is composed of the fewest possible parts. Four cast-iron wheels, with revolving axles, each wheel revolving separately, the axles being connected by a single spring on each side, in the centre of which is an iron casting, with two wrought-iron arms supporting a flat platform, which may be fitted with a basket or any kind of body required. The wagon only consists of five parts, exclusive of wheels and axles. With a load of from 20 to 30 cwt. it may be pushed along by a labourer.

## FOYLE NAVIGATION.

The great increase within the last thirteen years in the shipping trade to the Port of Derry has rendered the present accommodation of the port insufficient to meet the requirements of its gradually expanding trade. Many disabled vessels applying for repairs at the patent slip at present in existence, are compelled, in consequence of its limited capacity, to proceed to Troon, to the great detriment of the Derry trade. In the year 1840, the tonnage of vessels trading to the Foyle, including foreign and coasting steamers and sailing vessels, was 84,178 tons; whereas, in 1852, it amounted to 215,499 tons. To meet this great increase, the Ballast Board of the Port of Londonderry commissioned Messrs D. and T. Stevenson of Edinburgh, in 1847, to examine the harbour and estuary of the Foyle, with the view of reporting as to the establishment of a graving dock or patent slip, suitable for vessels of large tonnage requiring repairs, &c. Accordingly, a marine survey was made, and sections and borings taken; and from the data thus obtained, it appeared that the situation possessing the greatest facilities for the formation of a wet or graving dock or patent slip was that portion of the slob-land below the town, on the north side of the river, which extends from opposite the Asylum towards Pennyburn, called the New Land. This site affords an excellent foundation for marine works, the beach being composed of rock, covered towards low-water mark with a slight deposit of silt, and having a rise of tide of from 8 feet to 9 feet at springs; the depths also shoal rapidly from low-water mark to the navigable channel, so that the entrance to either a dock or slip would not be much removed from the current of the tides. The Messrs. Stevenson were also instructed to report on the relative merits of graving docks and patent slips, and the best means of withdrawing vessels from the water for the purpose of repair. Many applications have been resorted to for effecting this, both in our own and foreign countries, embracing the "Graving Dock," "Patent Slip," and "Gridiron," which have been generally adopted in the British dominions, and the "Hydraulic" and "Screw" docks, which are much employed in America. But the Messrs. Stevenson decided that the choice in the case of Londonderry must rest between the graving dock and the patent slip, and state the advantages which the latter possesses over the former to be as follows:—First, the cost of construction is less; secondly, where the fall of tide is languid, a vessel can be more quickly laid dry; thirdly, when so laid dry, it can be more easily examined; and from the greater duration of the daylight in such a situation, compared with that of a deep graving dock, the hours of work are extended, not less during winter months than forty minutes per day; and fourthly, although the upper part of the slip be occupied by a vessel undergoing repairs, an additional vessel may be taken up for a shorter time than its predecessor, without disturbing the progress of the works.

The advantages afforded by a graving dock, on the other hand, are—First, that although its construction is more costly, it is, if properly built, unquestionably a more durable structure, the rails, rollers, carriages, and chains connected with the slip being liable to derangement, and requiring occasional repair; secondly, the management of a graving dock is much more simple, and involves comparatively little superintendence; whereas that of a patent slip is intricate, requiring more than mere nautical skill; thirdly, the graving dock is equally simple, whether the docking of small or large vessels be considered, whilst the raising of a large vessel on a slip is a delicate operation, and can be attempted only under the direction of persons thoroughly versed in the matter, and having ample mechanical resources at command; fourthly, the graving dock possesses the advantage—which is sometimes of importance—of affording the means of partially filling a vessel with water, so as to detect leaks which may not be discoverable in any other manner; fifthly, the back water contained in the dock affords the power of scouring the entrance to it, a facility which the slip does not possess; sixthly, in any current or tide way it is a much easier process to dock a vessel than to land her safely on the cradle of the slip, an operation which, when not cautiously conducted, has been attended with accident even in sheltered situations.

The proposed graving dock for Londonderry was calculated to accommodate vessels of 1000 tons burden, and also to have room, at one time, for two square-sailed vessels of ordinary dimensions. For this purpose, the chamber of the dock would require to be 200 feet in length of floor, and 40 feet broad across the bottom; width of entrance, 45 feet. The depth of water on the sill would be 11 feet at high water of spring tides, which, as vessels always enter in light ballast, would be capable of floating vessels of very large draught. The rise of tide not being sufficiently great to admit of the efficient use of the dock without employing artificial means for emptying it, a pumping engine of 16-horse power would be required, fitted with saws and other gearing for cutting wedges, trenails, planks, &c. The slip, also calculated to receive vessels of 1000 tons, would require to be extended 220 feet landward of high-water mark at spring tides, and 378 feet seaward, so as to be 21 feet below the high-water level at its seaward extremity. The slope of the slip for vessels of 1000 tons to be not less than 1 in 18. An engine of 20-horse power would be wanted for working the slip, and carrying on the various operations connected with shipbuilding. The estimate for the cost of the dock, exclusive of land, but including 10 per cent. for incidents, amounted to 13,540*l*., or 15,626*l*., according to site selected; and for the slip, including cost of machinery, apparatus, and 10 per cent. for incidents, &c., also exclusive of purchase of land, 12,361*l*. In the year 1852, a second report was made, in consequence of the sites above mentioned having become private property.

The second marine survey extended from the Bridge of Derry to Culmore Point; and the only site available for graving docks or patent slips between those points was found to be the portion of slob land between Rock Mill March and Sir R. Ferguson's property. But as this site is proposed to be occupied by the Lough Swilly Railway and the Londonderry Improvement Scheme, the bills for which have been submitted to parliament, it is an important consideration for the city of Derry, whether these proposals should prevent the future extension of the docks and quays. The Lough Swilly Railway is intended to start from the "New Land," to pass outside of the Rock Mill, and thence extending downwards to pass the turnpike halfway between the roads leading to Pennyburn and Buncrana; thus cutting off from connection with the harbour of the only remaining available space for the extension of the Port of Londonderry, as has already been done by the Coleraine Railway on the eastern bank of the river, and by the Enniskillen Railway above the Bridge of Derry. The Londonderry Improvement Scheme proposes to occupy the slob land by a new town; so that the land which should be devoted to warehouses, docks, storing-yards, and ship-building stances will be devoted to the erection of dwellinghouses. The execution of either of these plans, as at present proposed, would, in the end, prove a serious drawback to the prosperity of the shipping trade of Derry, upon which it is so considerably dependent.

The Foyle presents great facilities for navigation, as regards depth of water. The dredging required in connection with the graving and basin or tide docks proposed by Messrs. Stevenson would be principally confined to Rosse's Bay, Culmore Point, and the inclosure opposite to Thornhill. The quays recently constructed by the Coleraine Railway Company would require to be removed to preserve the lines of conservation laid down by the Lords Commissioners of the Admiralty.

The estimate for this extended scheme, including 10 per cent. for incidents, &c., would amount to—

| | |
|---|---|
| 1. Quays from Londonderry Bridge to Patent Slip, inclusive of dredging to 10 feet below low water ...... | £26,000 |
| 2. Quays from Patent Slip to Graving Dock, including dredging in front to 10 feet below low-water mark | 16,000 |
| 3. Graving Dock and Wet Dock .............................. | 28,000 |
| 4. Dredging at Rosse's Bay to 13 feet below low water... | 10,000 |
| 5. Excavation, &c., at Culmore Point ........................ | 400 |
| 6. Deepening of Flats........................................... | 10,000 |
| Total .......................... | £90,400 |

## THE FRENCH METHOD OF CONSTRUCTING IRON FLOORS.

By H. H. Burnell.

[*Paper Read at the Royal Institute of British Architects, Jan. 9th.*]

In describing the system of the "Planchers en fer," or Wrought-iron floors, it is not my attention to enter into a detailed account of the various experiments made before the systems now so generally used in Paris were brought to their present state of perfection,—to occupy your time with calculations of the resisting powers of rolled iron, or discuss the suitability of the forms adopted; but avoiding all that might tend to embarrass the question, I propose to confine myself to a succinct and simple description of the systems now most frequently executed, and to furnish such practical information as I have obtained by visiting the works where they are employed, and hearing the opinions of the architects conducting them.

It would seem that, for some years past, floors composed of rolled iron joists have been occasionally executed in Paris; in most cases, the joists were flat and without flanges: such constructions were known as the Système Vaux. The systems to which I am about to draw attention are little more than an improvement in the form of the joists, and may be said to have come into general use at the commencement of the extensive alterations in the Rue de Rivoli, in the spring of the year 1852.

In the various works treating on the subject, several systems are described, but upon visiting the Parisian buildings now in progress, we perceive but two: one purporting to be the system of M. Thuasne, and the other appearing to be that of any one who may get an order to execute it. From the observations made by parties conversant with the matter, I am induced to believe that the different systems are no longer recognised in general practice, and that the architect or builder combines at pleasure the advantages of all.

The "Système Thuasne" may be described as being composed of joists of iron, rolled in the form of the double T, and slightly arched in the proportion of 0·005 mètre in the mètre or of 1 in 200. They are placed at the distance of 1·00 mètre (or 3 ft. 3¼ in.) from centre to centre, and are united by interties, formed of flat iron bars, fixed at the same distance of one mètre apart. These interties rest on the lower flanges of the joists, and are let into wrought-iron bands fixed round them; a small pin is then driven through the hole at the extremity of the intertie, between the joist and the band, and the transverse tie is formed.

The fantons are light iron rods, from ⅜ to ½-inch square, of the same length as the joists, and parallel with them; they are laid on the interties, and bound to them with copper wire, and may be said to take the place of the ceiling laths. Some of the joists and interties next the walls have their ends so formed as to make them act as ties; thus the ends of the system being firmly built into the walls, the sides of the house are effectually united. The iron-work is usually painted, and allowed to dry thoroughly, before it is brought to the place of construction.

The above-described net-work of iron being completed, the next process is the plastering or grouting. This process differs so materially from the English mode of forming a ceiling, and is so important a part of the scheme, that it requires to be understood before the success of the whole can be comprehended. It is done thus: a board or flat centering is placed under the part intended to be filled in; a grouting composed of the coarsest quality of plaster is then poured in upon it, and running in between the lower portions of the iron-work, it stops against the board beneath, and forms the ceiling of the room below, which one coat of fine plaster serves to finish. The plastering thus applied is from 2½ to 3 inches thick, and sets in about half an hour; it shortly becomes as hard as stone, and assists much to stiffen the floor.

The second system referred to differs in some degree from the first, the joists being placed nearer together, perhaps 2 ft. 4 in. to 3 feet apart. The interties are formed of iron bars, from ⅜ to ½-inch square, bent at the ends so as to clip the upper flange of the joist, and again crooked downwards to rest on the lower one; the elbow so made pressing against the side of the joist, a strut and tie is at once formed between the joists. Interties upon this principle are of course made as nearly as possible of the same size, and when placed between the joists, a blow with the hammer is sufficient to fix them in their position, and make them touch at the required points. They are placed about 3 feet apart, and as nearly as may be in a direct line, so that one may resist the action of the other. The fantons or light iron rods lying parallel with the joists are laid on the interties, and the grouting performed as in the former method. The floors of the new Louvre are made upon this principle, and filled in with pottery.

It need scarcely be remarked of these rolled iron joists, that they may be made of any intermediate thickness between the stoutest and lightest of the patterns given, the depth of course remaining the same. This offers some advantages, particularly in France, where iron is dear, and the apartments divided into rooms of very different dimensions; as, in many cases, it may be desirable that the floor of the smaller room should be of the same depth as that of the larger one; but the span being less, the lighter description of joist would suffice, the internal walls being assumed to have the necessary strength to take the bearing.

As I have elsewhere observed, the grouting is always more or less of plaster, but in many cases the space between the joists is filled with pottery, that is to say, small cylinders of baked earth, about 7½ inches high and 4 inches in diameter, having the ends closed, and somewhat resembling flower pots; these are bedded in a layer of plaster, poured in between the lower portions of the iron-work, and then receive a grouting to fill in the insterstices. Perforated bricks, and pipes like those used to form land drains, are manufactured for the purpose, but are rarely used. Where a wooden floor is required (which is frequently the case) it is nailed to small joists notched in between the iron joists; sometimes, however, where economy of space is less an object, the wood joists are laid across the top of the iron work.

With regard to the relative merits of the two systems, little need be said: that of M. Thuasne binds the joists more effectually at the bottom, where they are best calculated to resist the expansion of the plaster, and it may also be accompanied with some trifling economy of iron; but notwithstanding this it has the character of being on the whole the dearer, and on this account the other method is more generally adopted. Both offer advantages on the score of being easily fixed, and when executed with common intelligence, answer well, producing a light fire-proof floor in two-thirds of the space of the ordinary wooden construction. It will be seen that floors made upon either of these principles are as incombustible and sound-proof as most others professing to offer the same advantages. It is clear that violent heat, if long continued, would calcine the plaster and ultimately bend the joists; but even in this case, were pottery of any kind judiciously employed, it would offer a serious opposition to the flames, and would be infinitely less dangerous to those in or near the building than cast-iron girders or joists with heavy masses depending upon them.

It is with some misgiving that I speak concerning the cost, feeling that it is unlikely that a common calculation made from the French tarifs should be found a correct guide to the expense in England, as so much depends on the skill and enterprise of the parties undertaking the manufacture, the effect of competition, and the demand for the material. Perhaps for present purposes it may suffice to consider the probable prices in England to be the same as those of Paris, for it should be remembered that though we have iron in greater abundance, the wages of English exceed those of French workmen. The want of a material like the French plaster will next be felt. I am not aware that we have anything that effectually takes its place at a moderate expense. The price of French plaster in London is 32*s.* or 33*s.* per ton, about 30 per cent. dearer than in Paris; but I believe I am correct in saying that this plaster, when fresh, may be mixed with an equal quantity of sand, cinders, or ground brick, and answer the purpose in question. The cost of grouting in England must therefore be considered as double that of Paris.

| Bearings. | Depth of Joist. | Depth of Floor complete. | Weight per Square. | Iron Work, per Square. | | | Including Grouting. (12 Shillings) per Square. | | |
|---|---|---|---|---|---|---|---|---|---|
| ft. in. ft. in. | inches. | inches. | lb. | £. | s. | d. | £. | s. | d. |
| 10 0 to 11 6 | 4 | 7⅛ | 370 | 2 | 19 | 5 | 3 | 11 | 5 |
| 11 6 to 13 0 | 4¾ | 7⅞ | 420 | 3 | 6 | 5 | 3 | 18 | 5 |
| 13 0 to 16 6 | 5½ | 8⅜ | 465 | 3 | 14 | 4 | 4 | 6 | 4 |
| 16 6 to 20 0 | 6¼ | 9½ | 510 | 4 | 1 | 9 | 4 | 13 | 9 |
| 20 0 to 23 0 | 7⅛ | 10¼ | 605 | 4 | 17 | 6 | 5 | 9 | 6 |
| 23 0 to 26 0 | 8⅜ | 11¾ | 700 | 5 | 12 | 4 | 6 | 4 | 4 |

The accompanying table is translated from a tarif of prices circulated by M. Thuasne last year; it also gives the weights and depths of the floors for the various spans.

I regret that I am not in a position to furnish more ample information on this head, and that I am unable to produce accounts of some experiments which might convey an idea of the resisting powers of the floors when complete, though I know that these experiments have been made; but perhaps, the general adoption of one or other of the methods may be received as the best guarantee of their results being satisfactory.

In connection with the subject of the general use of iron in France, much might be said on the French manner of constructing wrought-iron girders, but as the most remarkable of these are to be found in the buildings of the new Louvre; and as we have just heard that all matters connected with that important building will be treated at a future meeting by our Honorary Secretary for Foreign Correspondence, I shall abstain from offering any remarks on the subject.

In conclusion, I would add that I have been induced to offer the foregoing remarks, because I conceive that an invention that is well received in a city so important as Paris, must be practically interesting to us, particularly if in our own country the advantage of that invention be partially wanting; it is true that our mode of building and inhabiting our houses differs generally from that of the French capital, where they are usually let in apartments or flats, but in many instances the same arrangements occur here, and in such cases, at least, we might avail ourselves of the experience of our talented neighbours. Many prejudices and conflicting interests must be overcome before any invention can be generally adopted; those of the Parisian building world seem to have yielded readily to the desire to improve, and the opportunities offered to the development of a new method by the extensive character of their alterations; and though the improvements in our own metropolis proceed with less vigour, we may endeavour to evince as little prejudice as our neighbours in our inquiry into the merits of that principle, which constructively has done its part to invest their newly-erected buildings with stability and refinement worthy of the age.

The Rèvue Generale de l'Architecture contains the following experiment, made upon a floor 16 feet span (Système Vaux) the joists being $5\frac{1}{4}$ inches deep, $\frac{3}{8}$-inch thick, and cambered 2 inches in the 16 feet. Upon the grouting being filled in the camber was reduced to $1\frac{3}{4}$ inch; upon the floor being loaded with 1000 lb. per yard super. it was reduced to $1\frac{1}{16}$ inch, and after forty-eight hours pressure again decreased to 1 inch, the deflection from the load being $\frac{3}{4}$-inch; the weight being removed, the floor resumed a camber of $1\frac{9}{16}$, having lost $\frac{3}{16}$ in the experiment. When filled in with pottery, these floors are lighter, but the filling in with solid plaster forms the whole into a stronger and more solid mass.

*Discussion.*—Mr. G. R. Burnell, C.E. refered to a paper read by himself in 1849, in which he had alluded to Vaux's system. Since that time several works had been published on the subject, —the most recent and the best being one by General Morin, who in the fourth volume of his "Cours de Construction" gave an elaborate set of experiments on the resistance of these floors, and the formula on which their thickness and general dimensions might be calculated. From these experiments it appeared that a floor of 26 feet span showed a deflection of seven centimètres, with a weight of 70 lb. on the square foot, in addition to the weight of the floor itself. It appeared to him (Mr. G. R. Burnell) that one of the great objections to the modern French system of filling in with plaster, was not so much the weight as the expansive action of the plaster. In practice the effect of this was to bring the floor down nearly half the amount of deflection, produced by the extreme load which the floor would bear. The use of pottery was therefore preferable, and it would be especially so in this country, where plaster of Paris was comparatively expensive. The conflagrations which had lately occurred in the city rendered it important to devise some incombustible flooring; and it was to be much regretted that in England insurance from fire was a tenant's tax, instead of being a landlord's tax, as in France, because there was no inducement to builders and landlords in this country to construct fireproof houses.

Mr. Donaldson, observed that the rent was regulated in each case with reference to this fact, and Mr. Godwin considered that the prevalence of short leases, instead of freeholds, might equally explain it.

Mr. Papworth, referred to a house in Hinde-street, Manchester-square, built by Dr. Gillies, the Scottish historian, the roof of which was made of cast-iron bars, little more than $4\frac{1}{2}$ inches deep, with a sufficient flange, and filled in with flower pots, precisely as in the French method, but cambered so as to form a vault. This had always stood exceedingly well until the walls began to settle; there was then a fracture which had caused considerable trouble; but that had been remedied, and the roof still stood very well indeed. With respect to the expansion of the plaster, mentioned by Mr. G. R. Burnell, he could not understand why it should press downwards, when there was no abutment above to prevent it expanding in an upward direction.

Mr. Fowler observed that it had an abutment above; being turned up against the joist, in a form equivalent to a curve; and, therefore, if expansion did take place, it must press downwards.

Mr. Piper stated that the plaster would expand in all directions. The floor at Messrs. Clowes's printing office was of the ordinary construction, with timber joists; but a plaster of Paris ceiling was attached to it, or a sort of flat centering was fixed and secured below the joists, and the plaster was filled in from above the laths; the laths being of oak, and stronger than usual, both in material and scantling, and placed at a wider interval. The plaster therefore passed through and formed the ceiling below, and a sort of pugging above: it consisted of two parts of sand to one of plaster. The floor was constructed of three courses of plain tiles, in order to make it a perfectly fire-proof and air-proof chamber, used as a drying-room; no bad effects had arisen from the expansion of the plaster. With reference to the use of cast-iron in floors, he had had great experience in those constructed on Fox and Barrett's principle; and it had always occurred to him that cast-iron was an unsound material to be subjected to a permanent set, and to be strained as a floor was liable to be; and therefore the introduction of rolled iron joists, which were produced so successfully at the Butterley Works, was a great advantage. Six floors had been constructed with cast-iron joists in the Albert-buildings, Spitalfields; and at the top of the building a defective joist broke, and fell down vertically, striking out one joist in every floor as it fell, without disturbing the rest—an illustration of the extreme brittleness of the material. Regarding the concrete as an addition to the weight, without being any addition to the strength, or having any natural cohesion or connection with the iron, he had not been prepared to expect a very firm floor as the result of the combination, in a span of 18 to 20 feet, in a coach manufactory in Regent-street; but on the contrary, he was surprised to find that, when the mass became set, it was rigid to an extraordinary extent, forming a kind of uniform landing, in which there was a good brotherhood between the concrete and the iron, the whole forming a trustworthy mass. With regard to the cost, his experience had shown him that in Messrs. Fox and Barrett's construction it was equal to that of an ordinary floor, with the addition of the price of the floor boards; but the present state of the iron market would somewhat interfere with that calculation. From the actual rigidity to which he had referred, he was disposed to think the French floors described would have a great amount of strength. Alluding generally to the facilities for the spread of fire in houses, by means of skirtings, staircases, quarter partitions and roofs, as at present constructed, he illustrated the power of an ordinary plaster ceiling to resist the action of fire, by referring to a severe fire on his own premises, which began in the shop, and spreading upwards by the staircase ignited the roof, and then burned downwards. The first-floor was however left entirely perfect, and the second nearly so; the only obstacle to the fire reaching them being the plaster ceiling of the ground-floor, where the fire commenced.

Mr. Barrett said that, from the remarks made that evening, he was more convinced than ever that the use of iron in the construction of floors was only a question of time. With regard to these French floors, their liability to deflection was a radical defect, as no finished floor ought to be liable to the slightest deflection or want of rigidity. The system described could moreover prevail only where plaster was abundant—as in Derbyshire, Leicestershire, Nottinghamshire. Objections were also raised to plaster on the ground of its imparting a disagreeable smell, and of its tendency to swell. He had adopted rolled iron in his own method in consequence of the prejudice against cast-iron joists, and he proceeded upon this safe principle: that, taking the concrete as so much dead weight, his joists were so proportioned that that dead weight, together with the extreme load which could subsequently come upon the floor, should not exceed the elastic limit of the iron. He used rolled iron joists for spaces not exceeding 24 feet. On reference to the table of weights used in Paris, he found that the French floors had not more than half the strength of his own; thus, with a bearing of from 16 ft. 6 in. to 20 feet, the French used a weight of iron of 510 lb. per square, whereas he should use 8 cwt., in addition to the difference in the weight of the grouting; and therefore, if the French floors were safe with 5 cwt. of iron, his floors must be more than safe with 8 cwt.; and the cost of the latter, in joists 18 inches to 2 feet apart, as compared with a timber floor, was about 7 to 10 per cent. additional. The thickness of concrete, on his plan, in a floor of 20 feet span, would be 7 inches from the flange of the joint, the whole substance being 12 inches thick, including 2 inches for the floor itself; and as a question of expense, it would be very easy to reduce the strength of the iron (and with perfect safety), so as to bring down the cost to that of an ordinary timber pugged floor.

Mr. C. H. Smith stated, for the consideration of the members, the fact that no material could be more destructive to iron, especially wrought-iron, than plaster of Paris. The girders might be coated with some material to protect them, but in moving them about it was liable to be chipped off; and if the smallest pinhole were exposed to the plaster of Paris, the iron would be corroded. On the contrary, lime tended to preserve iron; and therefore a coating of 2½ inches of ordinary mortar next to the girders, before using the plaster of Paris, might be desirable.

## APPARATUS FOR ASSAYING PRECIOUS METALS.

J. A. Staffel, *Inventor.*

This invention is intended to supersede neither the solution by fire, nor the various chemical tests which have been brought to a state of great perfection: it is simply designed for practical purposes, when neither acids nor fire can be made available. The apparatus is constructed on the principle of *specific gravity,* which has been extended to *specific volume.* The great difficulties to be contended with were, 1st, the elasticity of the air; 2ndly, its temperature; 3rdly, capillarity; 4thly, the closing of the apparatus hermetically; and, 5thly, the furnishing a scale for various weights; but after four years of unwearied study and labour Mr. Staffel overcame these difficulties. The apparatus consists of a glass tube, fixed in a brass case, the bottom of which forms a cylinder, which receives its movement by means of a screw. An annular dial, furnished with a *hair,* for an indicator, shows the degrees from 0 to 99, and controls the motion of this screw. The degrees, from 100 and upwards, are indicated on a plate, fixed at the side, which plate stands in connection with the dial.

The glass tube is closed hermetically at the top with a glass cover, to which is annexed a capsule, a perpendicular glass cylinder, and two brass bars, serving as a scale.

By the side of the apparatus is a bar, by means of which the dial is brought to zero, and at the same time the fluid in the cylinder is reduced by means of a handle to the normal point. The object to be tested is then weighed by means of weights adapted to the purpose; after which the object is placed in a grate suspended within the fluid, and the capsule carefully closed. The handle is then set in motion and turned, until the weight, previously ascertained, is indicated upon the dial, while the fluid in the perpendicular cylinder will rise to a degree corresponding with the figure on the dial. The figure thus obtained gives the alloy, the remainder the amount of pure metal. For example, if it be required to test an object weighing 24 grains, it will be necessary to stop the dial-hand at 24, and of the fluid in the cylinder, then 8, the result will be

$$24 - 8 = 16,$$

which will give the standard of the gold.

If the gold be alloyed with silver and copper, which will be indicated by the paleness of the colour, it will be necessary to refer to the brass bar for the purpose of showing the alloy. The differential weights of the alloy between gold and copper, and between gold, silver, and copper, are indicated by various scales.

If the object weigh 39 grains, and the cylinder show 11, then the result will be

$$\frac{39 - 11 \times 24}{39} = 17{\cdot}23 \text{ proof.}$$

The volume of fine silver or gold is marked ............... F;
The volume of copper, or any other alloy is marked ... C;
The volume of specific difference is marked ............... D;
The volume of weight is marked .................. 1, 2, 3, &c.

If a fusion of $28\ F + 11\ C$ is to be made, the figure must be $F = C - D$, of $F + D = C$, or $28\ F + 11\ C = 39\ F + 11\ D = \frac{11}{39}$ copper or alloy.

The practical utility of the instrument will chiefly be—

1st. The determining the quantity of gold or silver used in manufacturers' wares from either of these metals, and thereby enabling the employer to ascertain whether the finished article contains the exact amount of metal furnished to the workmen.

2ndly. In ascertaining, if required, the value of a chain, though the gold used in the several links be of a different standard.

3rdly. In previously ascertaining the standard of a fusion, when various sorts of silver, of unequal size and weight, are to be melted together.

4thly. In ascertaining the value of coins with the greatest accuracy and dispatch.

## THE PUMPING ENGINES AT THE BIRMINGHAM WATER WORKS.

By W. S. Garland, of Soho, Birmingham,

(*With an Engraving, Plate* VIII.)

[*Paper read at the Institution of Mechanical Engineers.*]

These water works were established in the year 1830; the Company then erected two engines, having cylinders of 61 inches diameter, and 8 feet stroke, each working two pumps of 18 inches diameter, and 6 ft. 8 in. stroke, respectively to the lower levels of the town, or working one pump only when raising water to the upper reservoir. These engines were of sufficient power until the year 1850, when the company erected an additional pair of pumping engines, manufactured by Messrs. James Watt and Co. of Soho. The cylinders of these engines are of 72 inches diameter, and 10 feet stroke, working a pump of 23 inches diameter, and 10 feet stroke, under a head of 252 feet, which with the heads in the main and friction, is equal to a total resistance of 285 feet, and to a load upon the plunger of 124 lb. per square inch or upon the steam piston of 13 lb. per square inch. The weight upon the plunger required to overcome the load upon the air-pump, the friction of the engine, and to maintain a velocity of 10 strokes per minute. is nearly 26½ tons, which is equal to 142 lb. per square inch upon the area of the 23 inch plunger, and 14½ lb. upon the piston. The power, therefore, of each engine when making 10 strokes per minute, is equal to 180 horses; and the total power which the company now have for supplying the borough is equal to 530 horses. The steam cylinders A, A, have steam cases, and are enclosed in a covering of felt having an outside casing of wood, B, B, to prevent the radiation of heat; the tops of the cylinder and upper nozzle are covered in a similar manner.

Fig. 1 Plate VIII., is an elevation of the engine and pumps; and fig. 2 a section on a larger scale of the main pump, suction and delivery pipes, and air-vessel. Fig. 3 is a vertical section of the cylinder, with its piston and rod, and side section of the nozzles. Fig. 4 is a front section of the nozzles; showing the steam-valve C, equilibrium-valve D, and exhaustion-valve E. These valves (on a larger scale in figs. 5 and 6) are 13, 15, and 18 inches diameter respectively, and of the double-beat construction; by which the principal part of the pressure that the common conical valve is subject to, is removed. The steam governor valve F, is made of the single conical form (there being no necessity for making this valve upon the double-beat principle), and is regulated by a screw and wheel handle.

The load upon these engines is a variable one, to the extent of the difference of the dead level of the upper reservoir and the amount of friction of the water *in transitu,* and it sometimes happens that the water is being drawn off faster than the engine supplies it, and the velocity of the water beyond where the great draught occurs is consequently decreased, and the resistance proportionably diminished.

To prevent any accident to the engine by going out too suddenly, in consequence of this diminished resistance, a throttle-valve G, is placed between the upper and lower nozzle, and in the pipe communicating with the top and bottom of the cylinder, which is regulated by a screw and wheel handle in a similar manner to the steam governor or throttle-valve; and by thus contracting the passage, or wire-drawing the equilibrium, the equalisation of pressure between the top and bottom of the

# PUMPING ENGINE, BIRMINGHAM WATER WORKS.

Fig. 1.
Elevation of Engine & Pump.

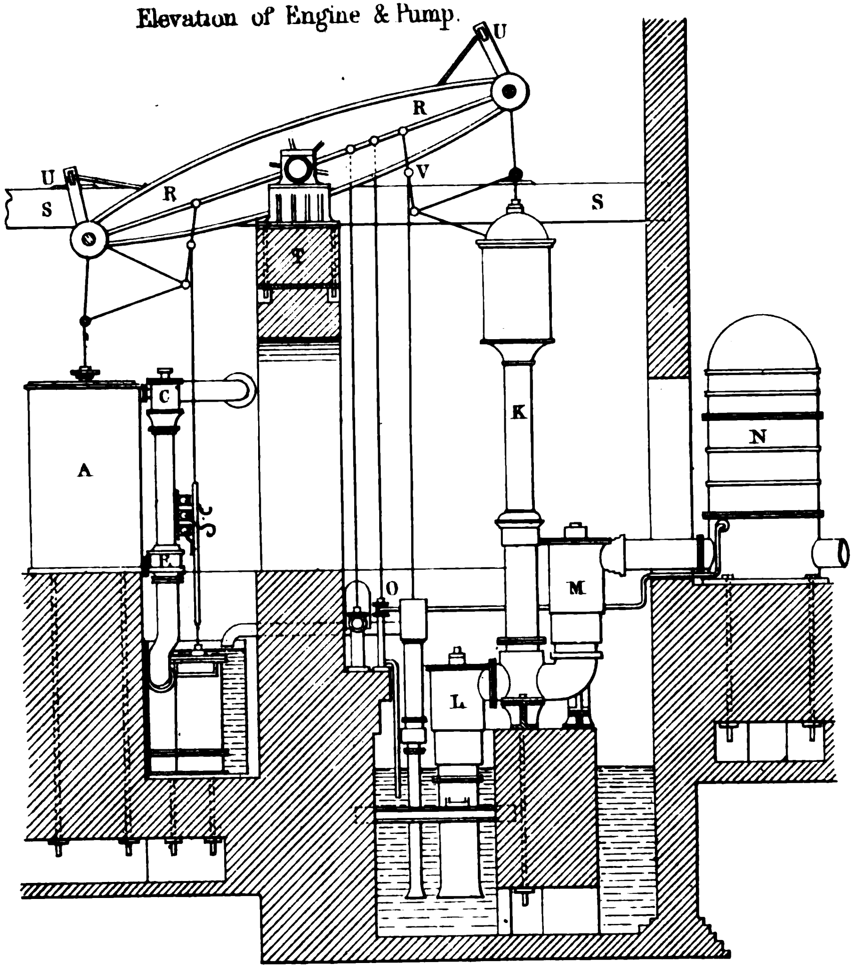
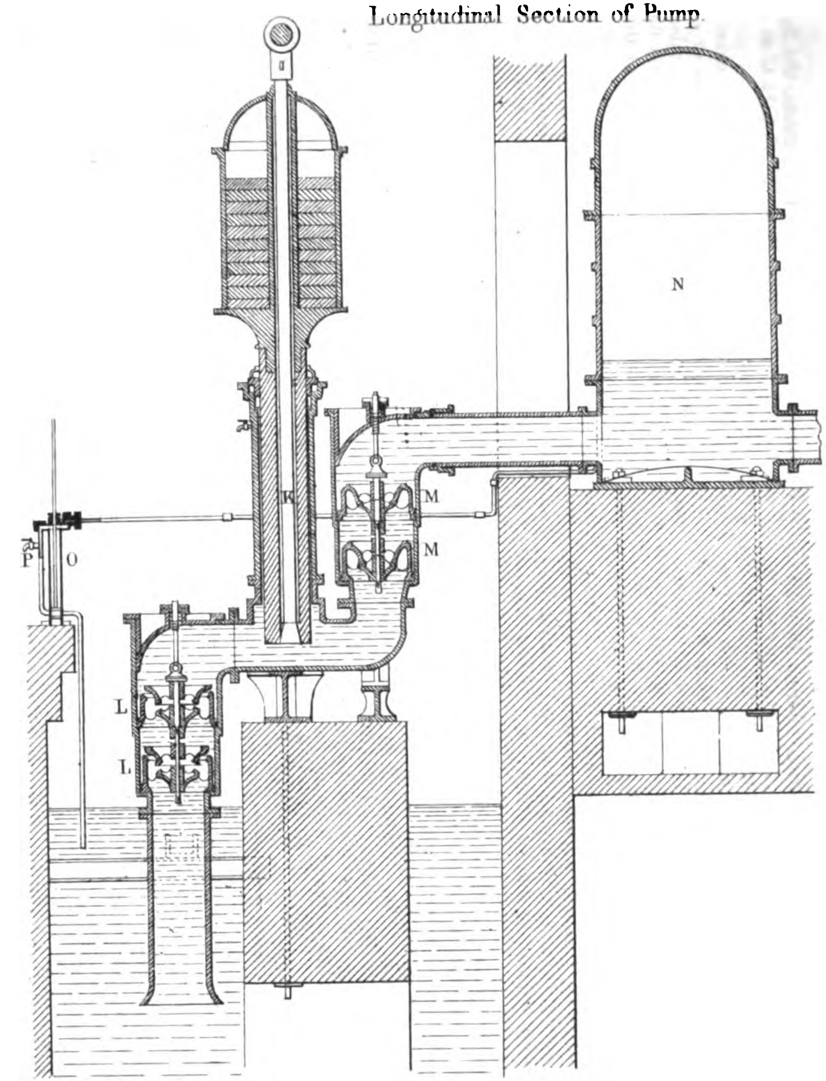



Fig. 2.
Longitudinal Section of Pump.




J.R. Jobbins

cylinder is more slowly formed, during the time the plunger is descending, to the extent the weight is in excess of the diminished resistance, acting like a break without absorbing any power or causing any disturbance to the working of the engines. The piston is represented in fig. 3 as descending, making its in-door stroke, the steam and exhaust-valves are open, and the equilibrium-valve closed. In fig. 4 the steam governor-valve F, and the equilibrium governor-valve G, are represented as wide open.

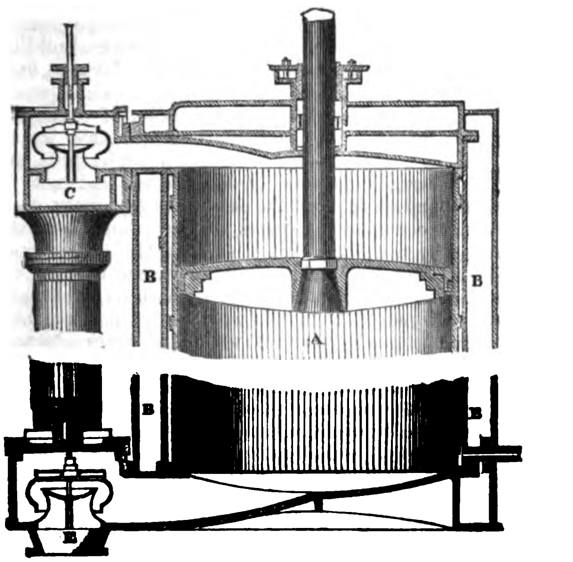



Fig. 3.

The opening of the steam, injection, and exhaustion-valves is regulated by a cataract, and the speed of the engine is thus under the control of the engine-man. The equilibrium-valve is opened by quadrant catches, and is dependent upon the closing of the exhaustion-valve, the former being opened upon the closing of the latter, and is shut in the usual manner by a tappet upon the plug-rod.

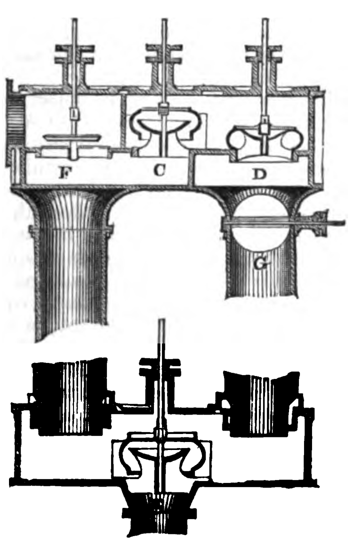



Fig. 4.

The injection-valve is also made upon the double-beat principle, to render the strain upon the exhaustion-valve spindle as little as possible, by relieving it of all unnecessary pressure, the underside of it being open to the condenser.

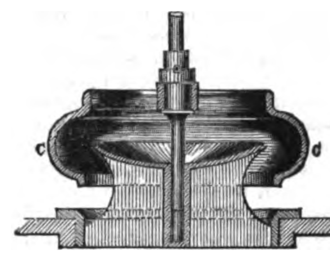
In the event of the bursting of any pipe in the main, and the resistance to the plunger being suddenly removed, a detent is fixed upon the plug-rod, to prevent the repetition of a blow upon the spring beams by the catch pins. This detent comes into action upon the engine when making more than its usual length of working stroke, by holding the steam-handle down, and thus preventing the opening of the steam-valve. This adjunct to the hand gear, though it may never be brought into operation from such an occurrence, would evidently be of great value in such a case.

In fig. 1, H, is the air-pump, and I, the condenser; both of 34 inches diameter and 5 feet stroke. The air-pump bucket is fitted with a brass annular or ring valve, and the delivery and foot valves are of the usual construction, or what are termed flap valves. A vacuum is obtained varying from 27 to 29 inches, according to the state of the atmosphere.

Each engine has its separate condenser cistern, formed of cast-iron, which is supplied by a cold-water pump of 13½ inches diameter and making 5 feet stroke.

The feed-pump W, is of 6½ inchos diameter and 2 ft. 6 in. stroke, fitted with an air-vessel. The plunger K, is 23 inches diameter and of the same length of stroke as the steam piston. The suction-valves L, L, and the delivery-valves M, M, (shown enlarged in fig. 6) are of the double-beat kind, and fitted in pairs to give additional security to the action of the pump in the event of one of them sticking or becoming otherwise deranged. They are of cast iron, and their beating faces are composed of a mixture of tin and lead, which is run into a dovetail recess turned in the cast-iron seat, and thereby becomes perfectly fixed. The water-way through these valves is of the same area as the plunger, and the lift of them is about 2 inches; the blow, when shutting, being scarcely perceptible.

Fig. 5.



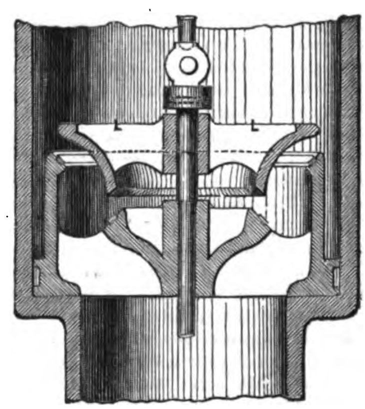




Fig. 6.

The air-vessel N, is 7 feet internal diameter and 18 feet high, or 15 feet high above the delivery branch into the main, and it is replenished with air by a separate pump O, of 6 inches diameter and 3 ft. 6 in. stroke. An air-cock P, is fixed upon the suction pipe of this pump, by which the necessary quantity of air to be supplied is regulated. This cock only requires to be partially open, and when closed entirely, the pump lifts water only.

The air-vessel is of great importance, as by its equalising action the motion of water in the mains is rendered continuous, and a less weight in consequence is required to give the necessary velocity to the descent of the plunger in the out-door stroke. At the top of the pump-plunger is fixed the pole case, containing the necessary weights to overcome the load or resistance, and, as before stated, is equal with the plunger and rod to about 26½ tons.

Upon the first delivery pipe joining the air-vessel is fixed a safety discharge-valve of 6 inches diameter, loaded by a lever and weight a little above the pressure upon the main, to prevent any undue force being thrown upon the pump from the accidental shutting of the sluice cocks between the engines and the town.

The main lever or working-beam R, R, fig. 1, is 30 feet long, cast in two plates, each of 3 inches in thickness, and the depth of it in the middle is 6 feet, and at the ends 2½ feet. Each of the plummer-blocks has saddles of cast-iron between them, and the wooden spring beams S, S, which latter are 30 inches deep and 20 inches wide, of the best Memel timber, and formed of 6 pieces in section, bolted and bound together with wrought-iron straps. These beams are carried by the lever wall T, and by the end walls of the house.

The catch pins U, U, are of wrought-iron. The parallel motions V, V, are of the usual kind, which require no further explanation than what is shown in the drawing of the general elevation of the engines.

The quantity of water lifted by every stroke of each engine is equal to 180 gallons, or 1800 gallons per minute, and 108,000 gallons per hour, weighing upwards of 483 tons lifted in each hour.

## JAMES TRUBSHAW, C.E.*

Mr. James Trubshaw was born at the Mount, Colwich, Feb. 13, 1777, and was therefore four years and a half senior to another eminent member of the same Society (of Civil Engineers) whom in after-life he was proud to call his friend, and to whom he looked up with sincere respect and affection, the late George Stephenson, Esq., by whom, in turn, as also by his distinguished son, he was met, on all occasions of intercourse, with the most kind attention and courtesy. And here, it may be observed, that (allowing for individual diversities) there were many points of resemblance between that very remarkable man and himself, both in character and in career. Both were strictly men of original genius, of great natural talent, and persevering energy; both were of simple, open, manly bearing; both had been subjected to the discipline of actual work in younger days; and both were the makers of their own eventual reputations and positions of life. It may be added, that both were equally esteemed and respected, wherever known, as men of unblemished integrity. But it is not intended to run parallels where neither comparison nor contrast is needed, and where the celebrity of each rests on its own solid foundation. The points of resemblance have been alluded to only because they were fellow-labourers of the same generation, for the benefit of their country, in a common department; and because in Mr. Trubshaw perhaps the last is gone of the old school of engineers, whose works will be handed down to posterity as records of intuitive genius combined with singular practical skill. For Mr. Trubshaw, like his great contemporary, had few advantages of education; but in its stead he seemed to be gifted with an instinctive perception of all great mechanical principles, uniformly guided by excellent common-sense.

In earlier life his abilities became gradually known, chiefly within his own county, where he acquired the favour and esteem of many of its aristocracy. His first special patroness and friend was the then Mrs. Sneyd, of Ashcomb, to whom he himself always attributed his start in the world; but throughout life he received unremitting encouragement and kindness (and even posthumously) from other members of that much-respected family. The late Sir Thomas Cotton Sheppard and his father may be mentioned as other constant friends; and, at a latter day, Sir Geo. Philips; by all of whom his tried worth was consistently appreciated: but his name was well known and esteemed through the county generally. At a later day, Mr. Trubshaw became Engineer of the Trent and Mersey Canal Company, in which capacity his services and works were of the most valuable kind, whether in the way of construction, repair, or supervision. The various reservoirs, feeders, railways and other works which he directed for that company, bear equal witness, in one form or other, to his judicious management or able contrivance.

As an architect, Mr. Trubshaw was naturally without classic pretensions; but his designs were always cleverly arranged for purposes of convenience and comfort. It was, however, as a builder that his talents were most conspicuous. Among his domestic works in that department, Ilam Hall, near Ashbourne, and Weston House, in Warwickshire (which he built for their respective owners, after designs of Shaw and Blore), may be quoted as specimens of first-rate execution. In another line, by a bold and original conception of great simplicity withal, he accomplished a very remarkable work. The lofty tower of Wyburnbury Church, in Cheshire, had declined more than five feet from the perpendicular. At a small cost, and by no other process than that of carefully removing the earth on the higher side, by means of gouges adapted to the purpose, until the fabric above might gradually sink and settle by its own weight, Mr. Trubshaw restored the tower to its upright position without damage to a single stone of the whole building.†

In the outset of his career, however, his great fancy had been for bridges, and as his earliest works of any magnitude were in that branch of art and science, so were his latest and greatest. Perhaps the "Grosvenor Bridge" over the Dee, at Chester (so named by her present Majesty, then the Princess Victoria, at its formal opening in 1832), is, and will remain, his master-piece of ability. An elegant design for the structure had been produced by the late Mr. Harrison of that city, and its cleverness and beauty were readily acknowledged. To design, however, is sometimes easier than to execute; and where was to be found a man bold enough to undertake a work which—if ever completed—was to stand unrivalled in the annals of bridge-building? A single arch was to be thrown across the river, of a span exceeding 200 feet. Telford and other celebrated engineers had pronounced the feat almost impracticable; and the terms of contract alone, amounting to 36,000*l.*, was sufficiently formidable, for a work attended with so many possible yet undefinable hazards, at a day when the gigantic contracts of later time had not become familiar. Nevertheless, Mr Trubshaw courageously undertook the work. It occupied six years in the completion; the first stone having been laid in Oct. 1827, and the bridge opened to the public in Dec. 1833. This was of course a term of great anxiety and of severe trial. The perils, both by land and water, were many and great. Demands were sometimes urgent, while supplies were necessarily dealt out with rigid caution by managers who could not afford to listen to pleas of indulgence; turns of adversity now and then ensued, and (as will ever be the case) there were not wanting some who looked upon the undertaking with adverse eyes, or worse, whom predictions of disappointment, or even less worthy considerations, forbade to sorrow for any prospect of failure. Thus he, on whom the responsibility rested, was more than once reduced to very disquieting straits. But he was no vain theorist or random pretender, nether had he calculated his resources loosely; and, after many a fluctuation of cloud and sunshine, bold enterprise and honest perseverance had their reward. The design was achieved in full; and one of the many wonders of this kingdom now remains for a lasting memorial (as is hoped) of the builder's comprehensive genius and sterling courage. The simplicity of construction in the centres of this great arch (an invention of which he was justly proud), and the mode of slackening them to bring the arch-stones to their respective bearings, drew forth great admiration from the members of the society to which Mr. Trubshaw belonged, and by whom he was treated at all times with marked respect. A model of the bridge and centres (with some others of interest) was presented by him to the society, and a problem of no small importance has been solved in bridge architecture by the triumphant issue of this venturous and able work.

Though it be to pass from a greater subject to a less, there are some details connected with a later work of Mr. Trubshaw (also of very considerable magnitude), so graphically characteristic of the man, that this work would be incomplete winhout a reference to them. This was, ~~the erection of the~~ new bridge, called the "Exeter Bridge," over the Derwent, at Derby. More than one disastrous flood occurred in course of its progress, involving damage obviously fatal to all but the credit of the high-spirited contractor, then on the steady side of threescore years and ten. And now comes the characteristic evidence just referred to, as shown on occasion of a public dinner given at Derby, in celebration of the opening of this bridge in October 1850. The health of the builder having been proposed in complimentary and very feeling terms, with an allusion to his ill-fortune in the foregoing respect, coupled with good wishes for "all the enjoyment which intelligence and integrity could give to an old man in the last days of his life," Mr. Trubshaw replied in terms worthy of being recorded, as a specimen of what may be sincerely called "unadorned eloquence." "I am much pleased," he said, "that my conduct has met with your approbation. I have been in the habit of thinking all my life, but not of talking much; and if the bridge which has been opened to-day will carry us all well over, I shall be much gratified. With respect to the cost, it has never given me much trouble. When I was assailed by sudden floods, and by quicksands in the middle of the river, I soon found out where my profits would be. However, I have paid—or shall pay

* From the 'Gentleman's Magazine.'

† The compiler of this memoir conceives the work to have been accomplished as follows:—Supposing the inclination of the tower to have been from south to north (it matters not whether, in fact, it was so, or *vice versa*), a working trench was dug on the upper (or south) side across the breadth of the tower, and from this trench the ground beneath, as far as to the northern foundations, was scooped out, and made a sort of colander, leaving solidity enough, as the work advanced, to resist sudden or violent pressure, yet inviting its gradual subsidence through the weakness caused by the perforations. Whether this, however, be a correct description or not, the fact is indisputably sure.

in the course of a few days—all the expenses incurred; and I shall then burn the accounts and think no more about them. I thank the Mayor, in particular, and the gentlemen present, for the civility and kindness I have received during the progress of the work, and I hope the bridge will do credit to my memory when I am no more." The line in the play forcibly occurs here—

"Was ever tale
With a more gallant modesty rehearsed?"

Mr. Trubshaw's age and comparatively failing health after this period forbade his attempting a further work, to which allusion had been made, and which was at the time under serious consideration—namely, of erecting a monument to Mr. Geo. Stephenson, to consist of "a single stone which should be several feet longer than Cleopatra's Needle." The project was gravely entertained, and he himself was sanguine as to its feasibility; nor did his peculiar skill in the construction and application of machinery for all building purposes, leave much room for doubt that his combined genius and energy would have brought the scheme to a successful issue, had it been actually taken in hand, and life been spared to him. His ingenuity in surmounting difficulties of such kind as would have been involved, had been very conspicuously shown in the erection of a column at Ramsgate, commemorative of the landing of George IV. in 1821, of which he had undertaken the direction, at the request of Mr. Shaw, to whom his abilities had become at that time experimentally known.

In social life, Mr. Trubshaw was cheerful and friendly; abhorrent from every sort of affectation or pretence; and ready at all times to communicate his valuable ideas and stores of practical information. Order was a great feature of his mind, in all ways; and he was carefully deferential to those of higher degree with whom he conversed, without any tincture of servility. It may be added with truth, that as an employer, no master could ever have taken more thought and pains to render to all their dues—as well to those who served him, as to those whom he served. His guiding principle—on either side, and all his life through—was a single-hearted uprightness. As respected the just claims of workmen, his own early experience had made him a highly competent judge; and so great was his anxiety to do them justice always, that at an early period of his business—which he commenced at Stone, with very slender resources—neither he nor his very estimable wife would ever allow themselves any indulgence until the workmen's wages and all trade debts had been made secure. Many, at that time, were the long and weary walks he undertook in collecting his own dues for such purposes; and greatly distressing was it to both whenever those exertions happened to prove unsuccessful at the moment. And other like traits of honesty might be adduced in abundance, did such mere personal anecdotes belong to such general outline of character as the present.

In person, Mr. Trubshaw was of a commanding figure, tall and athletic, as may be judged in part from the somewhat singular fact of his having been one of seven brothers, whose aggregate height was not less than forty feet. He was married on the 21st Jan. 1801, to Mary, youngest daughter of Thomas and Mary Bott, who survives him, and with whom he truly found and shared, during a term of more than half a century, "that mutual society, help, and comfort, which the one ought to have of the other in married life, both in prosperity and adversity." A more thoroughly united pair cannot have been often met with. Forty-four years of their happy union were spent at Little Haywood, where he settled in 1809, and where they had the satisfaction of receiving from friends, in 1851, some little memorials of their wedded jubilee. Three sons and three daughters, of whom five remain, were the issue of the marriage; his eldest son, Thomas, an architect of considerable promise, died prematurely in 1842. His eldest daughter is the wife of Thomas Johnson, Esq., architect, of Lichfield.

It is pleasant to add, that Mr. Trubshaw eventually realised a handsome independence, although moderate in proportion to the extent of his labours and unfailing industry. He died calmly, on the 28th Oct. 1853, at Little Haywood, Colwich, Staffordshire, aged seventy-six, after a short actual illness, and was buried in the churchyard of Colwich, on the 4th Nov., having died as he had lived, a faithful and humble member of the Church of England. His death occasioned deep sorrow, and received, in his own immediate neighbourhood, that highest testimony of sincere regret —namely, of being felt as a private and personal loss in many houses beyond the circle of his own family.

## FORM OF CONSTRUCTION OF LIGHT-VESSELS AND BUOYS.*

In these go-a-head days, when steam and even sailing vessels are rivalling the speed of railways, observations on the construction of light-vessels may appear to carry us back to the dark ages, or to any other period of "no progress." Certainly, the task of devising the best means for preserving a fixed station in the midst of this turmoil of locomotion is not a very attractive one and by no means in accordance with the restless spirit of the age. But it is a subject, nevertheless, of great importance;—the safe arrival and departure from this country of our almost innumerable marine being dependant on an efficient stationary *light* flotilla.

The great public advantages arising from an improvement in the form and moorings of light-vessels and buoys has escaped the attention of our naval architects, who have been occupied by the more attractive consideration of that construction by which ships may pass through the water with the greatest possible velocity; and as the ship has thus became the sole mistress of the waves, she has been and is still in use for the purpose of stationary floating beacons.

A moment's reflection will, however, raise doubts whether the two opposite requirements, of speed through the water and of a stationary position upon it, can be best attained by the same form of floating body; and further consideration will show it is wholly incompatible with the nature of these requirements that such can be the case. It may, at first, appear that the form which is best adapted to pass through the water with the least resistance is also the form best adapted to permit the water to pass by it, but this condition is only a portion of the case and the remainder wholly deprives the argument of its force. It must not be forgotten that the stationary floating body is fastened to the ground beneath it in the midst of the moving waters. A consideration of this part of the subject will show that the above condition is only apparent, other circumstances not being the same.

The present form of a light-vessel being that of a ship, we will first notice in what respects this mode of construction may be considered disadvantageous. It is taken for granted that the present form of ship is the best possible for the purpose for which it is used and presents the least objectionable features; but notwithstanding this is the case and though she is moored with 1½ inch chain cable, estimated to be strong enough for a sailing vessel of 700 tons (a light-vessel being not more than 170 tons), yet the power of the sea over the vessel is such as to occasionally snap these heavy chains. Now when we consider that the sea when not opposed is harmless,—as witness, the bottles which have floated unharmed upon its surface over half the world,—it is clear that the immense power brought into operation to snap these strong cables must proceed *from the vessel herself*, and the power of the waves to break a vessel's moorings may be considered to arise principally from the leverage upon the chain, which her form necessarily brings into action. This action in ordinary weather may be harmless, but when the sea becomes rough it is then felt, and with a power which, under certain circumstances, is irresistible. Suppose, a heavy strain upon the cable from the weight of many tons at the end of a lever, as above mentioned, and the bow of the vessel struck by a sea at the same moment,—the chain breaks; for nothing can withstand the combination of these forces.

With respect to buoys the leverage is very evident, and it is this alone which causes them to break their cables. A buoy, having a displacement of about one ton, is moored by a ⅞-inch chain, calculated to hold a sailing vessel of 130 tons burthen; yet this small body will break such a cable. Buoys are generally moored from their lowest part. The lowest part is, in different sized buoys, at different depths below the surface of the water; but at whatever depth it may be below the surface (the axis upon which the buoy moves being upon the line of flotation), that depth is the length of the lever acting upon the chain, which, in its turn, reacts upon the buoy by the same length of lever. It is this lever which gives the sea power over the buoy to force it out of the perpendicular, the angle of inclination varying with the strength of the tide, and presenting an inclined surface to the sea, *to run up it* and act upon the upper part of the buoy;—thus bringing into play another lever. In very

* From the 'Nautical Magazine.'

violent weather these joint powers will cause a small body of one ton to break a ⅞-inch chain cable.

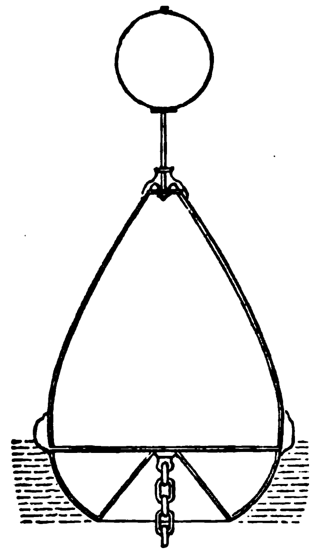
It results from these considerations that leverage action may be regarded as the chief cause of insecurity in our buoys and light-vessels, and that before improvement can be effected in the construction of these bodies this radical evil must be remedied. Nature generally points out the road by which the accomplishment of any object may be best attained, and naval architects have availed themselves of the beautiful lines which fishes afford them to construct their swiftest sailing ships. In like manner, let us notice the method by which nature moors her own stationary floating bodies. We shall find on referring to the floating leaves of aquatic plants; especially to the magnificent leaves of the Victoria Regia and to those of the Lotus and others, that the mooring is in the centre of a circular body, and that in these leaves the centre of the floating body and the centre of gravity are coincident upon the line of flotation. Now here appears the principle to guide us in the construction of light-vessels, buoys, and other *stationary* floating bodies. In a circular floating body of weight the bottom of it will be below the surface of the water; if, therefore, the bottom of the body be hollowed out and raised up, and the mooring attached to the upper part of the hollow cone thus formed, we shall be able to accomplish the results which nature points out as necessary to be attained, viz., the mooring from the line of flotation, from the centre of the floating body, and from the centre of gravity; which, with a due attention to the distribution of material, may be made nearly coincident, and a light-vessel or buoy thus constructed will ride upon the waves in the most violent storms without any leverage action whatever being brought into play.

The action of the waves upon a circular floating body moored from its centre of gravity will be very different, almost wholly so, to that which takes place upon light-vessels and buoys of the present construction, although it requires some little trouble to divest the mind of the habit it may have acquired of contemplating the action of the waves upon floating bodies having a head, stern, and keel.

A light-vessel of the proposed construction must be from 30 to 40 feet in diameter. A circular vessel of this size will appear at first sight to present a larger surface to the action of the wind and waves than a vessel having only 20 feet beam and 80 feet length, but this is apparent only, not real. It rarely happens that the wind blows from stem to stern of a ship; it usually blows upon the bow and slantwise upon the whole length of the vessel, the stern being borne up by the tide or the cross sea. The sea bears the ship up against the wind while the wind is forcing her back again upon the sea, and thus an antagonism takes place between these two forces, each exerting more power as it is more opposed by the other, the ship being to them the handle to wrench and tear her from her chain. In a circular light-vessel, moored as proposed, this cannot occur; the wind may blow upon it and the sea may heave it up, but there can be no combination of opposing powers. If the wind be very strong a certain known power will act upon the chain, and no more from that source; if the sea run very high the vessel will rise with it, and the only strain arising from the action of the sea (apart from the tide) which the cable will be subject to will be that which will result from the "scend" of the wave, which will be found inconsiderable. It is not supposed that the cable will be subject to no strain, but it is assumed that it will be liable to no sudden jerks and also to no strain that has not been previously considered and compensated.

Among the many advantages which will result from this mode of construction will be that arising from the absence of all pitching and rolling,—by which is meant any movement a vessel may make in excess of the angle of inclination of the surface upon which it floats. It may, possibly, be thought that because the mooring is attached to the centre of the vessel that it will oscillate upon its mooring point as upon a fulcrum, but this cannot take place; the weight of the chain bearing down from the centre of gravity, together with the body of water in the hollow bottom, will impart very great stability to the whole of the structure, and to whatever angle the vessel may incline it will be dependent upon the angle made by the body in which it floats and will not relate to the point by which it is moored. From these considerations it will necessarily result that a vessel of the proposed construction can never be struck by a sea. This is evident: the body will be simply borne upon the waves, it will offer no resistance to them, and there will be consequently nothing for them to strike,—in fact, the vessel will ride over the waves instead of the waves over it.

These advantages, claimed for a vessel of 30 feet diameter, have been found to result practically in the use of buoys of 6 feet diameter. The Trinity House has adopted buoys constructed upon this principle, and which are found to be superior to any yet tried. The accompanying figure is a vertical section of one of these buoys constructed of iron for them by Messrs. Brown, Lennox, and Co. On inspection it will be evident that the tide can have no power over the buoy to force it from the perpendicular by any haulage of the mooring upon it, or otherwise; indeed, the strongest tide has no effect in causing it to deviate from its perpendicular position, for whatever tendency there may be to produce a lean over by the tide pressing upon any side of it, it is directly counterbalanced by the pressure of the same tide upon the further or opposite side of the hollow cone.



There can, we think, be no question as to the correctness of the principle of mooring any stationary floating body from its centre of gravity, and there can be but little doubt that the more distant the mooring is from the centre of gravity, the less steady and the less secure is the floating body. A glance at the construction of bodies ordinarily used for stationary floating purposes will immediately convey an idea of their unsteadiness and insecurity; the centre of gravity is in one part and the mooring is attached to another far distant.

## ROTARY ENGINES AND BOILERS.

WILLIAM ANDREWS, *Patentee*, April 24, 1851.

THESE improvements have reference to—Firstly, a method of constructing rotary engines of two revolving parts, so arranged, that the steam having acted to propel one part, passes into and acts upon the other rotary part of the engine. Secondly, the construction of steam-boilers in such manner that the flame and heated gases arising from combustion shall pass up through a series of tubes placed vertically over the furnace, and communicating with a generator or combustion chamber, into which atmospheric air is admitted for the purpose of igniting the gases, &c., and thereby economising fuel and consuming the smoke of the furnace. The combustion chamber communicates with the smoke-box by a series of horizontal tubes. In the bottom of the smoke-box is placed a damper, regulated by means of a lever and rod. Thirdly, to the construction of pumps with two buckets, the piston-rod of one bucket passing through the hollow piston-rod of the other bucket. The foot and delivery valves are dispensed with. Fourthly, an improved safety-valve, consisting of a ring of metal, fixed concentrically in an annular opening by bridges or ribs. The ring and inner edge of the opening form the valve seat; the valve is formed of a solid circular piece of metal, and a solid ring, also connected by bridges or ribs. The solid piece fits into the ring of the valve-seat, and the solid ring of the valve fills the interval between the ring of the seat and the inner edge of the circular opening. By this arrangement, two or more concentric rings of escape are provided, instead of only one, as usual, thereby affording greater area of escape for the steam, and consequently greater safety on any occasion of sudden generation of steam. Fifthly, a method of welding on to the ends of railway axletrees a coating of iron, the grain of which runs around the axle, thereby rendering them less liable to heat than when the grain of the iron runs in a direction lengthwise of the axle.

## LIGHT FOR THE GOODWIN SANDS.

SIR—I observe in the *Edinburgh Evening Post* of to-day, that Mr. Sinclair, C.E., has proposed to erect a lighthouse on the Goodwin Sands, on a cone of rubble stones, constructed on the principle of the Plymouth Breakwater. The great importance of this matter to the maritime interests of the country induces me to ask the favour of your inserting this note, to afford me an opportunity of saying, that after very mature consideration, I came to the conclusion, so far back as 1848, that the plan which Mr. Sinclair has lately brought forward was the only practicable one by which the object desired could be obtained. In accordance with this view, there were made by my assistants in 1848, a detailed plan together with an estimate (amounting to 121,536*l.* 16*s.*) of the proposed works; and I had several communications with Captain Washington on the subject in January of that year.

The paragraph in the *Evening Post* states, that Mr. Sinclair proposes a rubble cone of 600 feet diameter, with a foundation platform at the level of 10 feet above high water, and 60 feet diameter. In my plans, dated 10th January 1848, I proposed a circular cone of rubble 610 feet diameter, and a platform also 10 feet above high water, of the diameter of 50 feet. The paragraph does not state what slopes are proposed by Mr. Sinclair: my plans show the slopes of 6 to 1. I proposed, before constructing the permanent stone lighthouse, to construct the first light on an open framework of timber, so as to allow time for the due settlement of the materials. The extreme height of the lighthouse was 67 feet above high water.

Being confident of the success of such a work as I proposed, and also that it is the only practicable method of overcoming the difficulty of the situation, I should be gratified to find that it is carried into execution. I send you herewith a description of the peculiar advantages of such a plan for a lighthouse on the Goodwin Sands, drawn up by me, some years ago, for an unpublished treatise on harbours.

I regret I have not, as yet, had an opportunity of seeing Mr. Sinclair's pamphlet.

84, *George-street, Edinburgh,* THOMAS STEVENSON.
*Jan. 7th,* 1854.

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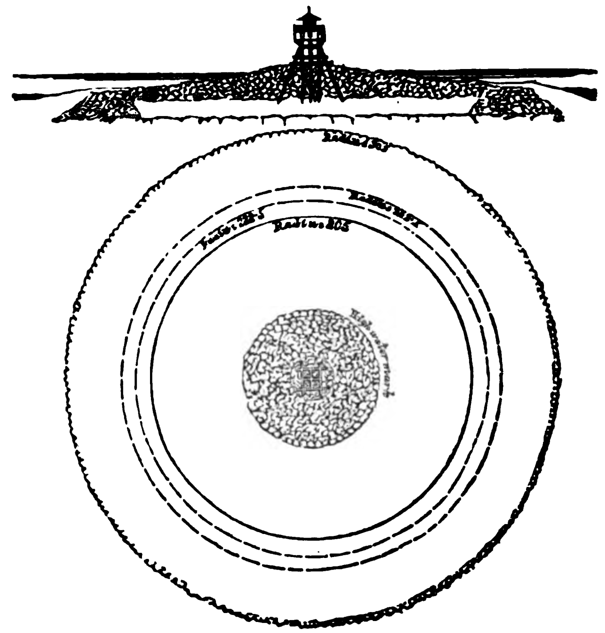
*Remarks relating to Proposed Light on the Goodwin Sands; from* Chap. III. *of an unpublished Treatise on Harbours, by* THOMAS STEVENSON, F.R.S.E.

This chapter may perhaps be best concluded by an example of the application of the principles it contains to a case of known difficulty. The case we shall select is, the long-talked-of light on the Goodwin Sands. We do not know any other similar case where so much ingenuity has been shown, and even carried into practice, as the light for the Goodwin Sands. Of the propriety or impropriety of having a light in such a situation we know absolutely nothing, and we have merely selected it as a type of a certain class of works in which ingenuity has been greatly more conspicuous than practical judgment. Our readers are no doubt familiar with the disinterested exertions of Mr. Bush in attempting to erect the "Light of All Nations" on this celebrated quicksand, as well as most of the chimerical designs which have from time to time appeared in the public journals,—not one of which seem in any way suited to the position. The question, then, may well be asked, whether there be any possible way of surmounting the difficulties of the situation. Before attempting to settle the point, we must first discover what is the objection which may fairly be urged against all the plans which have been proposed. These are, the adoption of the principle of mechanical fixture in preference to weight, and the too great disregard of the reaction from the structure against the sand-bank. There does not appear to be any special difficulty connected with the situation. Suppose there were no sand at all, the case would be in no material degree different from the light which is on the end of the Plymouth Breakwater, or any other light which is erected at any of our harbours of refuge. If we conceive the end of the Plymouth Breakwater placed on the Goodwin Sands, and suppose the quantity of rubble to be somewhat increased, the problem would be solved. Without abandoning the well-known and fully-tried principles of marine engineering, the object,—if it be one, for we express no opinion on that point,—could be accomplished by merely repeating that exceedingly simple operation which mainly consists in the throwing of stones into the sea, and allowing them to form their own slope, so as to form ultimately, after some years of labour, and the expenditure of 150,000*l.* or 180,000*l.* an island of *pierres perdues.* In this there is neither novelty nor should there be any doubt as to success, providing the principle be fully carried out. A similar plan was proposed in 1835 in America, but whether adopted or not we have no means of knowing. In the Appendix there will be some reports on the American proposal by Mr. Hartman Bache, and the engravings represent a plan of what was proposed. Such a plan, *if fully carried out,* possesses the following advantages over all the other plans for the Goodwin Sands' light:—first, absolute certainty of a successful result; secondly, the employment of a principle of construction which has already been successfully employed in many situations of as great difficulty and of greater exposure; thirdly, the impossibility of sudden total destruction.




PLAN OF PROPOSED LIGHT FOR THE GOODWIN SANDS.

The requisites for such a situation, which this plan only fulfils, are:—

1. Flexibility of the mass of material employed, by which it can adapt itself to the changes of form consequent upon unequal settlement.
2. That the structure shall rise out of the sand at a low angle, so as to reduce the effects of a reaction against the quicksand.
3. That that part of the structure where reaction must take place shall be far distant from the place where the light apparatus and residence for the keepers are situated.
4. That long before the work is completed, so that a light could be shown or residenters established, a beacon could be erected.
5. That no cofferdams, or caissons, or diving-bells are required in the construction.
6. That the greatest quantity of the material employed shall be of the cheapest construction.
7. That the structure shall not depend upon mechanical fixtures.
8. That if any partial damage ensues while the works proceed, the very ruins shall act as a defence against further encroachment.
9. That the sea cannot impinge with destructive violence at any place near the site of the light apparatus.
10. That it is not absolutely necessary that the structure shall reach the chalk *strata* under the sand.
11. That the great extent of the work can be done by untaught workmen, so that convict labour may be employed. And
12. That no iron or timber, which are so liable to decay in the sea, are required.

## ON THE WARMING OF CHURCHES.*

By J. H. Bigge.

It is very clear, from the more luxurious habits of the present age, as compared with the past, some artificial warmth is required, to render tolerable any lengthened attendance in those sacred edifices where our forefathers worshipped, without any contrivances for such a purpose. Since, therefore, it has become a matter, not only of importance to the comfort of those who are strong and healthy, but absolutely essential to the safety of the sick and the infirm, who are frequently precluded altogether, by the prevalence of damp or cold, from attending the services of our Church, it cannot be a useless inquiry to ascertain the best means for effecting this object in the least objectionable manner. It may be observed, however, that every attempt at warming a church will be found to be completely ineffectual, unless proper care be taken, in the first place, to remove those dilapidations which have been caused by time, or those deficiencies which have crept in through neglect.

Perhaps there is a decayed door; the windows may be badly glazed, and here and there a broken quarry; or the pavement may be damp or defective; these are the certain and self-evident sources of cold, which is thus fruitlessly and injuriously counteracted. The best method of preventing the annoyance arising from the cold air is to hang a curtain over the door, which is in every way more suitable than the red baize doors which we sometimes see, reminding us more of the entrance to a theatre than to a sacred edifice. A kind of thick felted cloth is manufactured for the purpose by Mr. French, of Bolton, in Lancashire (of which some specimens were shown).

Let us glance for a moment at some of the different contrivances which have already been resorted to for obtaining artificial heat. Cast-iron stoves of every kind, and size, and denomination, have been successively adopted, and as often thrown aside; it would be quite a task to discuss the respective merits of each, as it would be sometimes a difficult one to analyse the names they bear. There are the Phœnix, Vesta, Pyropneumatic, and Patent Chunk Stoves; there are stoves with descending flues; Joyce's stove without any flue; and the patent calorifiére gas stove, which requires no pipe, and will burn for twelve hours without any attention whatever.

No one can enter a church in which some one of these iron stoves has been placed without being forcibly struck with their unsightly and unecclesiastical character, and the great disfigurements which they generally occasion to all parts of the building. Pipes of every variety of shape, and size, and hue, are extended in every direction, either suspended by chains from above or supported by legs from below; they pursue horizontal, zigzag, and perpendicular courses above the pews or under the galleries; they are thrust equally through the bare walls or richly-traceried windows, violating all principles of correct taste, and in defiance of all ecclesiastical propriety. But, besides these evils, there are two great defects which will be found to exist in most of the iron stoves in common use. The first is especially to be noticed in churches and buildings with stone floors. However large the fires may be, and the heat they emit, there will always be, in winter, a current of cold air from the doors and windows, sweeping along the floor towards the fire, so that the few who are in a situation to feel the influence of the heat are, at the same time, inconvenienced by the cold. The greatest amount of heat will rise to the space above, whilst the air least warmed will remain on the lowest portion of the building, and always keep that part cold. Hence, though a person may feel warmth to his face, his feet will suffer from the cold of the pavement, and that part of his body will be chilled where warmth is most needed. The other defect is, the great waste of fuel in proportion to the heat obtained. It has been calculated that at least eleven parts of every twelve of the heat generated, passes in waste up the chimney.

Another objection to iron stoves is, that the heat, being transmitted through a metallic substance which expands under the influence of fire, carries with it any impurities existing in the coal which are evolved in combustion; producing that stifling and oppressive sensation which every one must have experienced who has come within their reach. I am bound to notice favourably, although it is an iron stove, one that has been placed in the churches of Brampton Ash and Wenford, since I am informed that it has answered its purpose, and because it is different in its construction from those I have mentioned. A well is sunk in the floor, 10 feet long, 2 ft. 6 in. wide, and 2 feet deep. In this is placed a cast-iron stove, about 1 ft. 6 in. square, with a pipe 6 feet long, having a closed ash-pit, into which drains are conducted from different sides of the building to supply the stove with cold air. The well is covered over with an iron grating, through which the hot air ascends into the church. The smoke passes away by means of a flue under the pavement, and is carried up the tower, and thus there is nothing visible in the building. The system of warming by hot water, conveyed in pipes along the walls, and on a level with the floor, is free from most of the objections just stated, and is effective in its operation; but the expense of laying it down, and afterwards maintaining it, is too great to admit of its being employed in ordinary cases.

Some years ago, the Cambridge Camden Architectural Society, in order to avoid the unsightliness of an iron stove and pipes, recommended an open brazier, filled with *coke*, to be placed on the floor of the nave or chancel, and raised on a stone plinth about six inches high, so that the whole might be about 18 inches altogether. This was to be lighted for an hour or two before service, and afterwards removed, when sufficient heat had been obtained to warm the church. This plan, however, has been very rarely adopted, since the dust and smoke which were unavoidably created would be with difficulty removed without the introduction of cold air.

I am informed that in Salisbury Cathedral, during cold weather, two or three large braziers full of live *charcoal* are placed on the floor in different parts of the building. Its great size, no doubt, prevents any prejudicial effects from the carbonic acid gas emitted, though it frequently produces a sensation of drowsiness, and, in a smaller area, it is clear that this method would be attended with dangerous consequences.

At Durham Cathedral, upwards of a dozen patent Phœnix stoves, which consist of an iron cylinder, about five feet high and a foot in diameter, are placed about the edifice; the pipes thrust out at the windows nearest to them; and the result, though unsightly enough, is tolerably successful.

In the Church of St. Stephen, Westminster—better known as that which has been built at the sole cost of Miss Burdett Coutts—a most complete system both of warming and ventilation is adopted, by means of which hot air, from a large furnace outside the building, is forced into flues constructed in the floor and walls. Cold air is admitted in a similar manner, and both can be regulated according to circumstances.

By the kindness of J. W. Hugall, Esq., architect, of Cheltenham, I am favoured with a descriptiou of a gas stove, which has lately been constructed with good results. It consists of an earthenware chamber, within which the gas-burners are placed. Around this there is another chamber, of the same material; between these two the fresh air is admitted, and is heated by coming in contact with the heated surface. A foul-air tube carries away any unwholesome vapour into a chimney.

The question of open seats in our churches having been at length decided by the general voice of public opinion pronounced in their favour, it becomes a matter of some importance to ascertain what is the best method of making them as conducive as possible to the comfort of the occupants, so that the objection to their being *open* may not operate in a manner prejudicial to their adoption. The object to be attained, therefore, in warming a church is to provide that a body of heat should arise from the pavement, which shall traverse as large a portion of the unoccupied area of the building as possible.

This principle of heating from below, under various modifications, was well known to the Romans, and seems to have been admirably adapted for the purpose. Rooms and baths heated on this system appear to have been provided in every Roman villa; and they have been discovered in England wherever the remains of Roman habitations are to be found. A short notice of them, therefore may not be uninteresting, as a record of their skill and contrivance in providing for the internal warmth of their houses.

The Roman hypocaust (from a Greek word signifying literally *fire or heat underneath*) was constructed in the following manner, as will be observed from the ground plan and section of one which has been discovered at Lincoln:—It consisted of a paral-

* Paper read before the Architectural Society of the Archdeaconry of Northampton.—This Society have appointed a sub-committee to draw up a report on church warming, describing some of the methods hitherto adopted, stating the expense of construction and of fuel, the area heated, the degree of heat gained in each case, with any further remarks they may think advisable.

lelogram 25 feet long by 10 feet wide, containing four rows of brick pillars, some square and others round, 2 feet high, standing 1 foot apart, upon a foundation of tiles. The ceiling was formed of large tiles 2 feet square; upon these was laid a stratum of cement or lime and pounded bricks, in which was set the ornamented Mosaic pavement, composed of small tesseræ or cubes of different colours, the whole being 10 inches thick. The fire-hearth was at one end, constructed under an arch in the outer wall, below the level of the ground, and the flame passed through the arched cavity or throat of the furnace directly into the hypocaust. The furnace was probably approached from without, in the same manner as the stoves of hot-houses at the present day. In addition to these supporting pillars, there were frequently rows of flue tiles, with a hole on one side, placed near, and built into the walls above, so as to admit and distribute the hot air over different parts of the building. The floor of the furnace was 18 inches below the level of the hypocaust, in order that the heat might thus rise to the roof; the large space which the furnace occupied was provided for the admission of air, and was also necessary for conveying a heated current through the flues, as the Romans were unacquainted with the use of a chimney for creating a draught. The hypocaust is well known to the Chinese and is in common use near Pekin, where the winter is very severe. The houses of the better class of persons are built with double walls, and with hollow flues extending beneath the floors. The fire-place is constructed against the outer wall of the room to be heated, by which means the annoyance from dust and smoke is avoided. The floor consists of flat tiles or flag stones, set in cement, so as to prevent the escape of smoke into the room. By this means, the heat coming in contact with every part of the floor is uniformly diffused over the apartment. The ingenious economy of the Chinese (from which we might often borrow a useful lesson) prevents the flues being choked with soot. Instead of employing coal of good quality, they use the inferior or refuse coal for this purpose, and mix it with clay, earth, or any decayed vegetable matter, and then form it into balls, which are dried in the sun. They find that these balls, during combustion, give out very little smoke. This method is not adopted from any scarcity of coal, but the Chinese know how to use it to the best advantage.

I have thought it necessary to carry these remarks upon the hypocaust to some length, because the description will almost entirely apply to the system which I am about to recommend. It will be evident, from what has been just stated, that most of the objections which have been made to the ordinary iron-stoves may be, in a great measure, obviated by the Roman plan, with such modifications as will adapt it to our requirements. By a reference to the plan of Rockingham Church, it will be seen that the furnace is constructed three feet below the level of the floor, at the north-west corner of the building. It consists, as the section will show, of an arched chamber, for the fire, 2 feet deep and 1 ft. 6 in. high, and 10 inches wide, from which a flue, 1 foot square, conducts the smoke and hot air, by a gradual rise of six inches in a foot, or, where practicable, the flue may be brought up immediately to the surface. The throat of the furnace is contracted, by the insertion of a bridge at the top, in order to cause the consumption of as much smoke as possible in the fire, before it enters the flue. This portion of it, viz. nine feet, is constructed with fire-bricks and tiles, and it is here that the greatest amount of heat is produced. The flue starting from the dimensions of 1 foot square, gradually *increases in width* to 2 feet, but *decreases in depth* to 4 inches when it reaches the level on which it is to proceed. The flue is then conducted along the passage between the seats, the pavement itself forming the roof. Blue and red Staffordshire tiles laid alternately, lozenge-wise, form the pavement; they are set in cement, resting upon common blue slates, which are supported at intervals of 6 inches by thin bricks set on edge in the middle of the flue, the whole forming a solid substratum, and by no means unsightly. Staffordshire tiles are used because they will best stand the fire, and from the difficulty of obtaining any stone which will answer this purpose. Supposing the passage to be 5 feet wide, and the flue 2 feet, there remains a space of 1 ft. 6 in. on each side from the wood-work of the seats, thus preventing any danger from over-heating. The flue proceeds along this passage to the extent of 60 feet, when it enters a chimney, formed by circular 9-inch tiles inserted in the wall, and carried up through the parapet.

I have also exhibited a plan of Weldon Church, showing the position of two furnaces, which, in this case, are required from there being a larger area to be warmed. It is of importance that the furnaces should be constructed in such a position that a certain rise may be obtained for the flues. The best place, in general, will be found to be under the porch; the ground underneath which being excavated, and a vault formed, easy access is obtained to the furnace, as well as a convenient receptacle for the fuel. An important advantage is gained by this position of the furnace; every time the door is opened, and a current of cold air enters, it is immediately warmed by coming in contact with the heated tiles just above the furnace; and then it is carried on, provided there are open seats, without doors, in the first instance to the feet, which are thus kept comfortably warm. It will be seen that from the length of flue no heat is wasted, and the higher the chimney is carried, the greater certainty there will be of ensuring a good draught. Where practicable, the tower, therefore, is the best place in which to construct the chimney. In churches where one furnace cannot produce sufficient warmth, an ingenious contrivance has been adopted, consisting of a circular hole made in the floor to the depth of 1 ft. 6 in., 1 foot in diameter at the bottom, and 8 inches at the top, lined with fire bricks, and having a flue at the bottom running into the main flue, at the distance of about 3 feet. From the plan it will be seen that the shape of it is somewhat similar to that of a coffee-pot. This fire-hole is suitable for warming a vestry, or for portions of a church which may be too distant from the main flue. The principle on which it acts is that of a downward current; the coals are placed at the bottom, then some smaller sticks, and shavings at the top; these are lighted, and the flame is carried downwards by the pressure of the air above, igniting the wood and coals, and consuming the smoke in descending.

The superiority of this plan of warming over that by means of iron-stoves, consists in the purity of the heated air which ascends from the furnace, and, being filtered, as it were, through the tiles, rises into the space above, purer than when contaminated by passing through any heated metallic substance. Other advantages are, the beneficial way in which the heat is produced at the lowest point in the building, its safety from fire, the only access to the furnace which is on the outside; the absence of dust, smoke, and dirt; and the economy of fuel. The person who has executed the work at Rockingham and Weldon, is Mr. Bradshaw, an intelligent builder at Leamington, who has warmed several churches and schools in that neighbourhood, on this system. The cost of it for the length and extent I have described, amounted at Rockingham to 35*l*.; at Weldon, to 65*l*. The materials were supplied by Mr. Arnold, tile and brick manufacturer, Tamworth.

Before concluding, I must not omit to notice one other method of keeping our churches warmed and aired, and which cannot fail to be attended with beneficial results, and that is, to open them as frequently as possible for Divine Service. Let this simple method be adopted, in addition to the artificial means already recommended, and we shall not have to complain of cold, which may, in some measure, be the result of a want of zeal and devotion in ourselves.

## ARCHITECTURAL INSTITUTE OF SCOTLAND.

The Fourth Session of this society, which has just closed, has proved highly successful, and augurs well for the future advancement of art and architecture in Scotland.

During the Session many highly interesting papers were submitted to the consideration of the members. Amongst others may be mentioned those of Mr. E. Sharpe, F.I.B.A., on 'The History of the Progress of Church Architecture in England, from the Heptarchy to the Reformation;' Mr. J. Lorimer, on 'The Peculiarities of the Church Architecture of the Rhenish Provinces;' Mr. R. W. Billings, on 'The Ancient Architecture of Scotland;' Mr. J. Baird, on 'The Chapel of St. Blane, in Bute;' Mr. Thomson, on 'The Materials used in Building by the Ancient Romans;' and a highly useful paper, by Mr. Lancefield, on 'The Drainage of Edinburgh.'

The success of the exhibition of models, drawings, and calotypes of architectural subjects, given in the Edinburgh hall of this Institute in March last, warrants the Council in announcing that a similar exhibition will take place this year in Glasgow.

## LOCKS AND KEYS.—BOX-STAPLES AND STRIKING-PLATES.

Michael Leopold Parnell, *Patentee*, November 6, 1851.

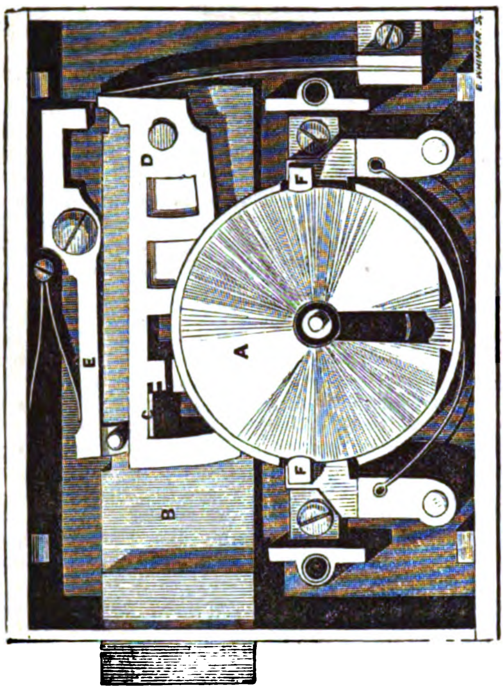



Fig. 1.

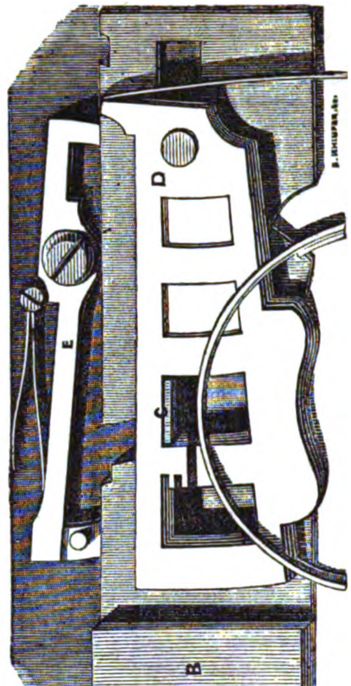



Fig. 2.

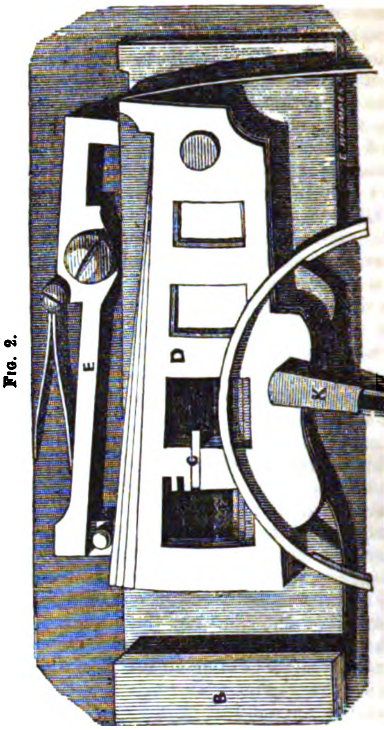



Fig. 3.

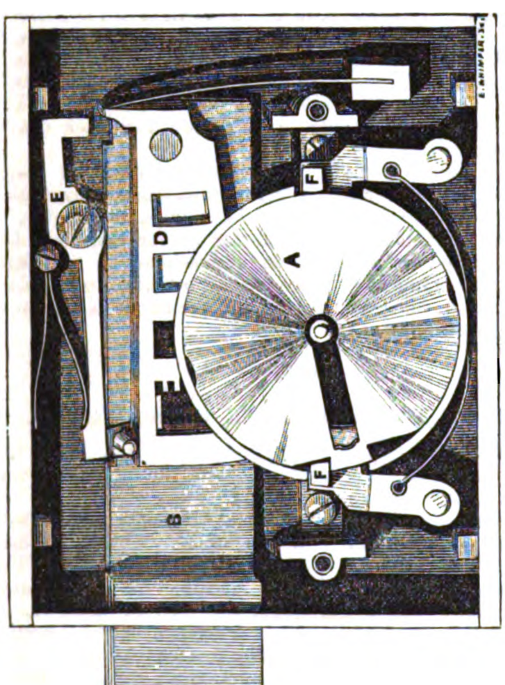



Fig. 4.

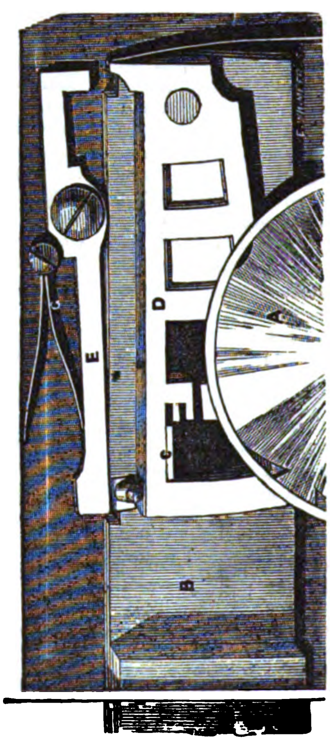



Fig. 5.

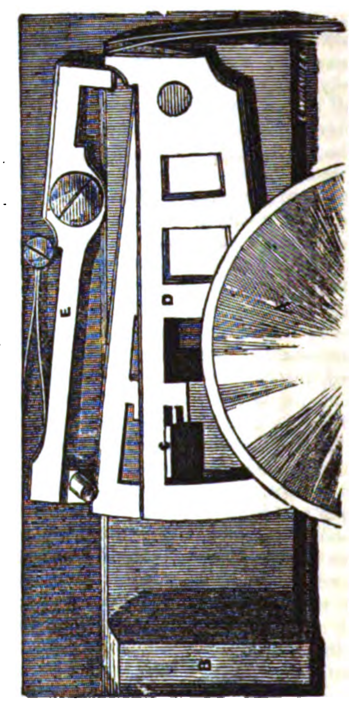



Fig. 6.

The lock, the subject of this invention, which the patentee calls the "Defiance Lock," is one of the best and simplest that has yet been brought before the public. There is no costly and complicated delicate mechanism; all the different actions of the lock work smoothly, with very little strain, and require no oil. All its parts, including those for protection or detection are brought into action every time the lock is used.

Fig. 1 of the annexed engravings shows the lock with the cover removed. A, is a metal cylinder, which revolves with the key or other instrument introduced into the lock, blocks up the key-hole, and thereby prevents the egress of any second pick or tool, and prevents any tampering with the internal works; B, is the bolt, and C, a stump or stud on the face of the bolt; D, the levers; E, the double-action latch; and F, the upright or vertical bolt.

The stump C, being shut up in the chambers of the levers, prevents the bolt from being moved by the pressure or strain of the key, until the levers are raised by the true key to the exact elevation to allow of the passage of the stump through their slots or gratings, when the bolt becomes amenable to the key, and the lock opens. In fig. 2 the stump is shown shut up in the levers; and in fig. 3 in the act of passing through the gratings. Should any instrument but the true key be introduced into and worked in the lock, it will, on making a quarter of a turn, come in contact with the sentinel or upright spring-bolt F, which takes into a notch or rack in the cylinder, and effectually prevents any further movement of the key, as shown in fig. 4. Fig. 5 shows the double-action latch E, above the bolt, working on its centre pivot, and pressed into a notch in the bolt B, by the spring G. Should any false instrument be brought to strain on the bolt, the stud on the latch E, sustains the whole pressure, to the relief of the stump and levers. In the event of the latch being lifted too high, the tail of the latch locks into the tail-catch of the bolt, thereby protecting the levers as effectually as by its first or primary action, and preventing the backward movement of the bolt, as shown in fig. 6.

On the shoulders of the lever are notches to receive the stump, which is made of steel, plain on its face and narrow. This stump, the moment the double-action latch is raised, glides into the notches in the levers, and prevents their being removed, to enable the bolt to pass them; at the same time the latch E, locks into a secondary notch or rack in the bolt, as shown in fig. 7.

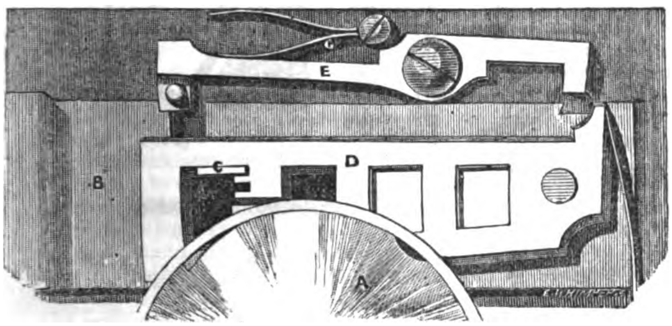



Fig. 7.

In addition to these several securities in the lock, the key is made in the peculiar manner shown in fig. 8, a view of the key as it appears when out of the lock; and fig. 9 the same when in the lock acting on the bolt and levers. It will be seen that the key, when not in use, appears like a highly polished "blank," or key before the wards or bits are cut in it. In this form it enters

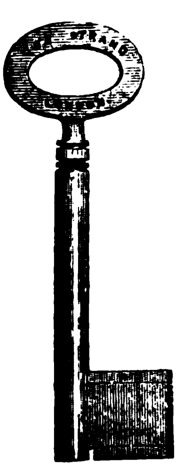


Fig. 8.

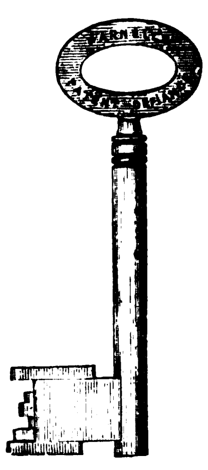


Fig. 9.

the lock, and fits on the edges of an eccentric steel-plate at the bottom of the pin. The moment the key begins to turn, the bits corresponding to the levers are gradually forced out by its action round the eccentric plate, so that when it has made a quarter of a revolution it has become slightly elongated, which enables it to pass the sentinel bolt, and by the time it has arrived at the levers it has expanded about one-third of its length; it then lifts the double-action latch E, adjusts the levers, and shoots the bolt. This construction of key prevents a duplicate being made from sight, as when out of the lock the bits or wards are secreted from view; or should a key be made capable of acting on the levers it could not enter the keyhole, so that the false key that can get in cannot work, and the key that can work cannot get in.

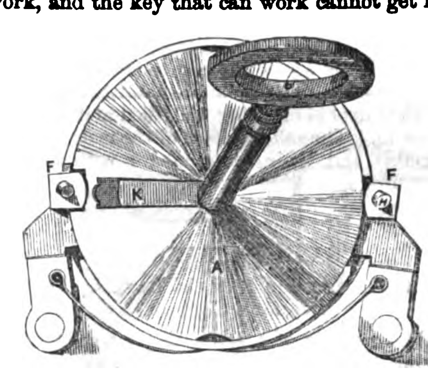



Fig. 10.

By a slight alteration in the cylinder, and the addition of a steel stud on the top of the sentinel bolt F, riveted on a spring underneath, a new arrangement is introduced (shown in fig. 10), which the patentee calls the Detention Cylinder or Detector. The effect is such, that should a false key be attempted to be worked in the lock, the upright or sentinel bolt F, will lock into the notch in the cylinder A, and the studs on the top of the sentinel bolts will be propelled into holes in the cover plate. By these contrivances the false instrument will be seized so firmly that it cannot be released without breaking the door or lock. This principle is peculiarly applicable to locks of safes, strong rooms, or other places where articles of great value are deposited.

There is also a supplementary arrangement, called the Master Key Detachment, whereby the possessor of the master key is enabled not only to open any number of locks of the same suit, where a variation of keys may be necessary, but also to throw them all "out" at pleasure, so that none of the ordinary keys can be of the slightest use until the master key, by its insertion in the lock, puts it into working order for them again. The mode by which this is effected is as follows:—By a simple contrivance, one of the levers in its ordinary position is held up or suspended; to render the key useless, it is only necessary to let it fall. By pushing a small square block that protrudes to the outside of the lock, about the sixteenth of an inch in, this lever is dropped. A small stud screwed into the block or kept apart, or a strong pin, will equally effect this purpose. To restore the action of the ordinary key, the master key has but to be turned in the lock to put the lever up again, and place it in its ordinary position for the key to act on it. This is an exceedingly clever and simple contrivance, rendering unnecessary any operations of "short locking," "double-locking," or the trouble of collecting and distributing a great number of keys, as is the case in banking-houses, prisons, or other large establishments.

This patent also includes a noiseless box-staple and striking-plate, the one adapted to rim locks and the other to mortice locks. The box-staple consists of a moveable plate, which yields to the pressure of the bolt, and offering little or no resistance, allows it to enter the chamber without the bolt being forced back into the lock. When the bolt is in the chamber the moveable plate being loaded at one end, falls noiselessly back into its place, and secures the bolt. The striking-plate acts in a similar manner, only rising to allow the bolt to pass instead of slipping to one side. This contrivance prevents all noise in opening or shutting the door, and all damage to the lock or jambs of the door.

## ARTIFICIAL STONE.

Juste Giret, *Patentee*, June 21, 1853.

This invention relates to the manufacture of artificial and malleable stones from all kinds of sand, earth, stone, and metallic earth. These materials are first submitted to the action of a strong heat in a peculiarly-formed furnace, and when the substances are at the point of red heat, they are impounded in cast-iron or granite mortars, and reduced to an impalpable powder. When thus triturated, fluxes, such as oxide of lead, boracic acid, potash, and soda, are added to the powder, for the purpose of more easily fusing the same. It is then put into a second melting furnace, from whence the products of the fusion are precipitated into a vessel containing cold water, when they are instantaneously transformed into the form of naturally-coloured sand. Different metallic oxides may be added to the mixture when in the melting furnace to vary or increase the colouring of the same. The matters, when cool, are again reduced to an impalpable powder, and placed in fire-clay moulds, and submitted to the action of the oven, for the purpose of being solidified and shaped into the form of the mould. The solidification of the materials being complete, the moulds and their contents are withdrawn from the oven, and deposited in cooling vessels.

## SASH FASTENER.

William Westley and Richard Bayliss, *Patentees*, December 23, 1852.

This invention consists of a self-acting fastener, applicable to windows having one or two sliding sashes, and to all window sashes with intermediate sash-bars, as the apparatus is so arranged between the bevil of the meeting bars, as not to project beyond the face of the sash, and therefore the sashes can pass each other without catching the other bars.

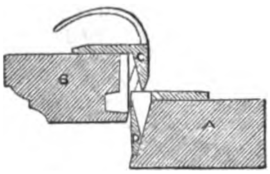


Fig. 1.

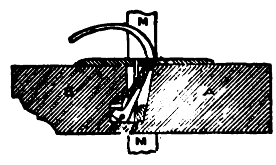



Fig. 2.

Fig. 1, is a section through one end of the fastener, as affixed on a sash (the sashes being a little way open) showing the inclined faces C, D. A, is the meeting bar of the top sash, and B, that of the lower one. When the window is being closed, the inclined face D, on the upper sash, comes in contact with and slides over the inclined face C, on the lower sash, and thereby draws the bars closely together; thus preventing the shaking of the sash, and also the admission of draughts, dust, &c. Fig. 2, is a section through the centre of the fastening, showing the sashes when closed, with the position of the bolt or lever securing the window. M, is the parting bead between the faces of the sashes.

When the window is quite closed, the spring-bolt or lever G, is forced forward by a spring H; the projecting piece I, falls under the shoulder K, on the opposite bar, and is there retained by the spring H, until released by pressing down the finger-piece L.

This self-acting fastener allows the window to be secured by simply raising or lowering either sash; and by passing a cord through a hole in the finger-piece, and drawing the lever L, forwards, windows of any height may be opened without mounting a stool or chair. In windows of upper floors that do not require to be locked, the spring and levers may be dispensed with, the sashes being clasped together by the inclined faces C, and D.

## OBTAINING MOTIVE POWER.

William Henry Fox Talbot, *Patentee*, December 13, 1852.

This invention is a new kind of electro-magnetic machine, consisting of a heavy iron cylinder, made to roll upon a long but narrow metallic table or plate, close beneath which a row of horse-shoe electro-magnets is placed. These magnets stand vertically, with their poles uppermost, so that as the cylinder rolls along the plate it unites the two poles of each magnet consecutively. The magnets are placed close together and level with each other. The cylinder is attracted forwards until it reaches the end of the row of magnets; the action is then reversed, and it returns in the opposite direction. The whole distance traversed by the cylinder makes one stroke of the engine. The cylinder communicates its force and motion to the rest of the machinery by its axis being attached to a crank and fly-wheel. The motion of the cylinder sets in action a commutator or rheotome, which magnetises the magnets that are before the cylinder, and non-magnetises those behind it; and is so arranged that the cylinder is not attracted by the poles of the magnet with which it is in actual contact, but by the poles of the next magnet.

*Claim.*—The general arrangement and construction of the engine.

## MASTS AND SPARS.

Robert McGavin, *Patentee*, October 23, 1852.

This invention relates to the so combining wrought-iron and timber in the construction of the masts and spars of ships, that great strength may be secured, with economy in first cost, and a reduction in weight and bulk.

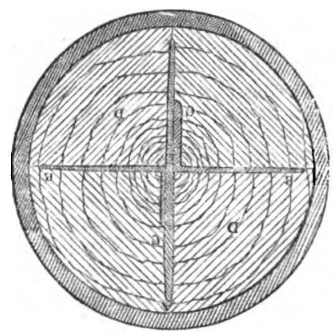


Fig. 1.

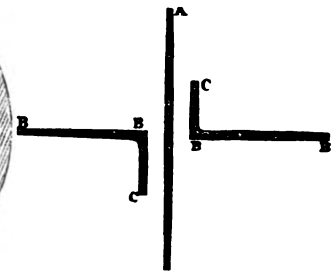



Fig. 2.

In building a mast or spar on this principle, the core or main centre is made of malleable or wrought-iron, of cruciform transverse section. One long plate of iron is taken, of a breadth equal to the requirements of the intended spar, and two other plates are attached at right angles thereto, one on each side along the centre. These two additional plates are each of half the breadth of the main single plate, the attachment or combination being effected by rolling or shaping an angle on one edge of each of the two narrow plates, so that the whole can be riveted together. The four spaces thus left between the four projecting edges or wings of the skeleton mast or spar are then filled in with pieces of wood glued up together with marine glue, or other adhesive substance; and the whole being hooped round with malleable iron hoops or rings, a light and strong structure is produced at a moderate cost.

Fig. 1 of the annexed engravings is a horizontal section of an improved ship-mast; fig. 2 shows the iron plates before fastened together.

In constructing a mast in this way, a long main centre-plate A, is first rolled and prepared to suit the required dimensions of the mast—the width of the metal being considerably less than the diameter of the finished mast. B, B, are the two additional side-pieces necessary to make up the intended cruciform section of the wrought-iron core. Each of these pieces B, has an angle C, rolled along one edge, so that when the two pieces are disposed on opposite sides of, and at right angles to, the main plate A, rivets can be passed through the angle-pieces B, and through the main plate along its centre line, to combine the three pieces into one frame, piece, or core. The four spaces or divisions D, are then filled with wood, so as to form a mast of completely solid cross section. The wood so filled in is not relied upon as a direct means of support or strength; its essential office being the filling-up of the divisional spaces to form a solid mass, and strengthen the buckling of the plates of the core. For, as the presence of a solid body between each two divisional pieces or wings A, B, prevents either of such wings from swerving out of its normal plane, it follows that each plate A, B, is disposed in the best possible manner to meet lateral strains—that is to say, all lateral strain is directed through each plate in a line parallel with the plane of such plate, where there is the greatest resisting depth of metal. Hence the filling-in wood may consist of short small pieces, as, provided the wood is sound, such short pieces, when well joined by marine glue or otherwise, so as to leave no objectionable openings along their central surfaces, are quite as efficient as longer ones.

This system of constructing masts and spars is suitable for a variety of works, and especially for the jibs of cranes where a combined longitudinal and lateral resistance is required. The filling wood may be made either to fill up the divisional spaces entirely or partially, but when filled up throughout, as in figs. 1 and 2, metal hoops E, are passed upon the structure to bind the whole well together.

## STUFFING BOXES.

Messrs. Weatherley and Jordan, *Patentees*, May 26, 1853.

This invention consists of a combination of several split or divided metal rings, with angular or wedge-formed sections, placed in succession round the piston-rod, and within a stuffing-box, the cover of which is kept down by screws and nuts, or springs.

Fig. 1 shows a half vertical section of a stuffing-box, showing the metal stuffing-rings, *a, a, b, b*, arranged alternately, according to this invention; the rings *a, a*, have their widest surfaces outwards, and incline inwards; and the rings *b, b*, are widest on their inner surfaces, and are bevilled towards their outer edges.

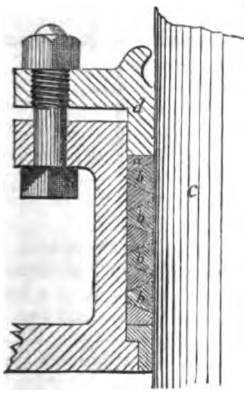


Fig. 1.

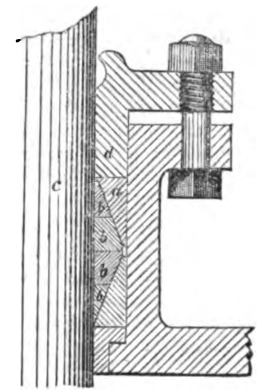


Fig. 2.

When the cover *c*, of the stuffing-box is pressed down upon the rings *a, a*, they tend, by reason of their widest parts being outwards, to force the other wedged-formed rings *b, b*, inwards, and cause them to closely embrace the piston-rod *d*. Fig. 2, a half vertical section of a stuffing-box, shows a different form and arrangement of the metal rings, acting on the same principle as those already described. The patentees prefer making the packing rings of tin.

*Claim*.—The mode of constructing stuffing-boxes by combining a series of split or divided rings, as shown and explained.

## ROTARY ENGINES.

Bristol and Underwood, *Patentees*, May 20, 1853.

These improvements consist—First, in so supporting the outer cylinder of a rotary engine that it is capable of rocking or moving in any direction necessary to preserve it in the proper position in relation to the inner rotating cylinder and the working parts attached thereto.

Secondly, in an arrangement for forcing out or withdrawing the sliders or wings which are acted upon by the steam, gas, or other fluid contained in the inner cylinders of rotary engines.

Thirdly, in a method of forming tight working joints between the outer and inner cylinders, and the working parts attached thereto.

Fourthly, in economising fuel in boilers for generating steam or gas, by increasing the radiating surfaces of the tubes or plates by corrugation, indentation, or abrasion.

Fig. 1 is a section of a rotary engine constructed on this principle. There is a quadrangular framing, having on two opposite sides plummer-blocks, which receive the journals of the main shaft S, to which the inner cylinder or steam-wheel D, is secured. C, is the outer cylinder, which is bored true and faced at the ends; it is surrounded by a double steam-space E, and has two lugs F, F, on opposite sides of its axis; the lower faces of these lugs are convex, to admit of the rocking or vibrating of the outer cylinder, and rest on suitable bearing faces *a, a*, on the top of the framing, at a suitable height to keep its axis in line with the axis of the shaft S. The steam space or band (seen in fig. 2, which is a half section of the engine taken through the steam-ports) has two passages *b*, $b^1$, both entirely encircling the cylinder C; the former communicating with the interior of the cylinder through openings *c, c*, and *d, d*, and the latter through the openings $c^1$, $c^1$, and $d^1$, $d^1$, seen in dotted lines in fig. 1. The passages *b*, $b^1$, are connected with the steam-chest G, by means of the ports *e*, $e^1$, which can be opened or closed in the ordinary manner by the slide-valve H, and handle I; *f*, is the exhaust port; F, the steam-pipe; K, the exhaust-pipe, fitted with a valve L. The inner cyliner D, is connected by four radial arms *h, h*, with its hub *g*, which is keyed to the shaft S. The heads M, M, of the same bore as the outer cylinder, are tightly secured by bolts to

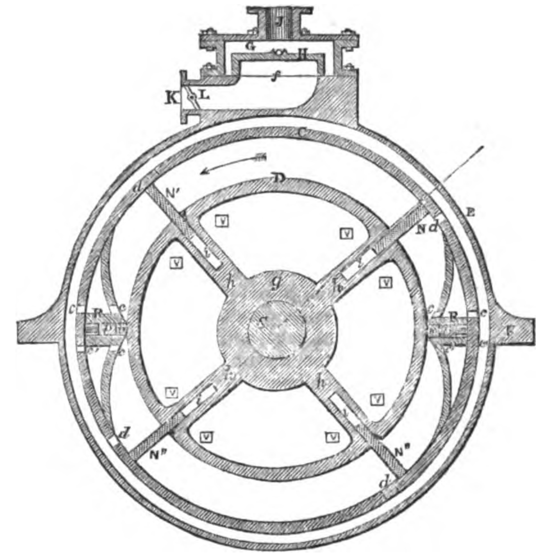


Fig. 1.

the ends of the inner cylinder D. The arms *h, h*, have radial slots *i, i*, to receive the sliders or wings N, $N^1$, $N^2$, $N^3$; corresponding slots are made in the heads M, M, O, O, and other heads, secured by bolts *v, v*, to the heads M, M, having flanges P, P. Q, Q, are metal packing-rings, which are pressed tightly

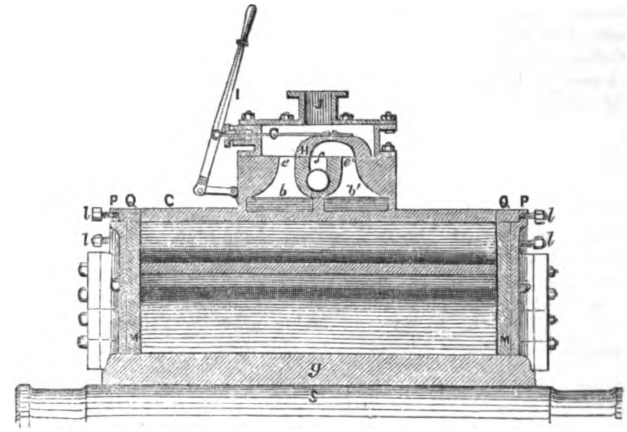


Fig. 2.

against the ends of the outer cylinder by means of set screws, and form a steam-tight joint. R, R, are the cylinder abutments; *m, m*, the face-packings, made in two pieces, and kept tight to the face of the inner cylinder by suitable means. T, T, (fig. 3) are

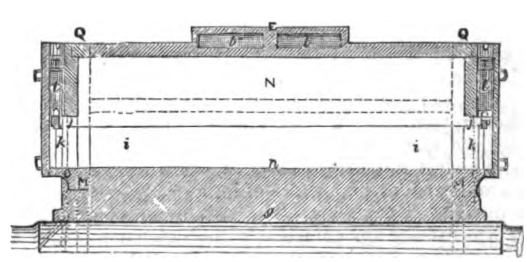


Fig. 3.

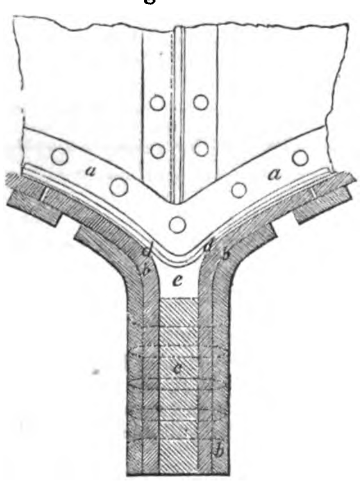
small pistons, working in radial cylinders U, U, and connected with the sliders or wings by the rods *t, t*, and arms *j, j*. When the engine is required to be started, the valve L, is closed, and steam admitted, which fills all the steam space within the engine, and forces out the sliders or wings N, $N^1$, $N^2$, $N^3$. The valve L, is then opened, and the passage or pipe *b*, filled with steam, which enters the cylinder C, through the openings *c*, *c*, and *d*, *d*, and acting on the wings N, and $N^2$, causes the inner cylinder D, to rotate in the direction of the arrow. The spaces between the sliders $N^1$, $N^3$, and the abutments have had the steam exhausted from them, so that there is no pressure on these sliders, nor on their pistons; they will therefore, as the rotation of the cylinder D, proceeds, be drawn in, by coming in contact with the rising parts of the abutments, without any resistance other than their weight and friction. To stop the engine, both steam ports are closed by the valve H; and to reverse it, the port $e^1$ is opened, and *e* brought into communication with the exhaust port.

*Claims.*—1. Supporting the outer cylinder of a rotary engine upon lugs or rockers, or in any other way whereby it is made capable of rocking or moving in any direction necessary to enable it to preserve its position in relation to the working parts contained within it; 2. The manner herein described of moving the sliders or wings outwards by the steam, gas, or vapour, and causing a joint to be formed between their edges and the interior of the cylinder, by its pressure acting upon pistons or their equivalents; 3. The manner herein described of making the moving joints between the ends of the outer cylinder, the rotating heads of the inner cylinder, and the steam and exhaust sides of the ends of the sliders, by means of adjustable metal rings, and by making the sliders exceed in length the space between the heads, such excess being formed of soft metal; 4. The employment in boilers or other vessels for generating steam or gas, of tubes or plates, having their radiating surfaces corrugated, abrased, chased, impressed, indented, raised, or made otherwise uneven.

## IRON SHIPBUILDING.

John Getty, *Patentee*, July 1, 1853.

These improvements in shipbuilding have reference to the construction of the lower parts of iron vessels, and consist in so arranging and shaping the frames or ribs and the garboard strakes of the vessel as will insure an uninterrupted passage to the pumps from stem to stern of the vessel for any water that may collect in its hold or bilge.




The annexed drawing represents a cross section of part of the hull of an iron vessel, built in accordance with these improvements. *a*, *a*, are the frames or ribs, which are bent or curved at their lower portions in the manner shown, in order that they may not touch the keel in any part; *b*, *b*, are the garboard strakes, which, for the purpose of strengthening this part of the vessel, are formed of two plates of iron on each side of the keel *c*, bolted or riveted together. The two inner plates forming the strakes are carried up sufficiently high above the keel to catch or touch the frames or ribs at the points *d*, *d*, and together with the keel form a watercourse or open channel *e*, running the entire length of the vessel; at the same time, the frames or ribs being bent across or bridging over the keel offer no impediment to the free passage of any water that may be contained in the channel *e*. Or, instead of the frames or ribs being curved or bent as above described, they may be brought to a point at their lowermost portions; the garboard strakes being made sufficiently deep to prevent the frames from touching the keel, and thereby destroying the continuity of the channel.

*Claim.*—The formation of an uninterrupted channel or watercourse from end to end of iron vessels, in the manner above described.

## GAS AND AIR ENGINES.

Fabian Wrede, *Patentee*, July 11, 1853.

This invention consists in causing a quantity of gas or other fluid to be moved backwards and forwards between two chambers in such manner that it undergoes no changes in its volume. During its passage from the one chamber to the other, the gas is alternately heated and cooled by a suitable apparatus, by which means its elasticity is alternately increased and diminished. Connected with the chambers is an ordinary working cylinder, with which the gas is in constant communication, and exercises an alternately stronger or weaker pressure upon its piston, thereby causing it to move backwards and forwards in the same manner as ordinary steam pistons. The motive power thus generated is applied to machinery in any convenient method.

## SCIENCE AND ART, PAST AND PRESENT.

By George Harding.

[*Address delivered at the close of the Twenty-Third Exhibition of American Manufactures, held by the Franklin Institute of the State of Pennsylvania.*

The Committee on Exhibitions have invited me on this occasion to deliver the closing address. Deeply sensible of the honour thus conferred, and feeling the warmest interest in the success of our Institute, I have ventured to accept their invitation. I fear that you will have reason to regret that their choice had not fallen upon one better fitted by age, occupation, and experience for the performance of this duty; or that a personal sense of unfitness had not, on this occasion, constrained me to decline.

With regard to the exhibition about to close, I need speak little. To tell you that it surpasses its predecessors, and has elicited the admiration of the community, is but to say that the mechanics of Philadelphia have displayed the fruits of one more year of labour and of genius; and that this has been appreciated by a discriminating public.

The promotion of the mechanic arts is the object for which this Institution was organised. Its agents in accomplishing that purpose are the stimulus of rivalry excited by annual exhibitions, and its provisions for systematic instruction in the application of science to the arts and manufactures. I have thought, therefore, that a sketch of the progress of the mechanic arts, as fostered, in times past, by these means, would be an appropriate, and, perhaps, not an uninteresting subject. My principal aim in this will be to show that the present advancement of our arts and manufactures results from, and their future progress is dependent upon, the intimate union of Science with Art.

The world was nearly six thousand years old before philosophy assumed her true position and became the handmaid to the arts. From the time of Socrates down to the middle of the sixteenth century, philosophy despised and neglected art, and art pined and dwindled for want of her aid. Philosophy preferred rather to devote herself to vague and impracticable theories of moral perfection, to subtle and unmeaning disputations. When she did deign to study natural and physical objects, such study was regarded merely as a mental exercise or diversion.

It is curious to observe to what extent this aversion of philosophy from art was carried under the sway of the lofty intellects of Socrates, Plato, and Seneca. Plato considered geometry as degraded by being applied to any useful purpose. Archytas, who lived about four hundred years before Christ, constructed machines of great ingenuity and considerable power upon mathematical principles, and is even said to have made a mechanical pigeon which could fly. Plato remonstrated with his friend Archytas, telling him that he was degrading a noble intellectual exercise into a low craft, that the true office of geometry was to discipline the mind. From that time all the mechanical arts were considered as unworthy the attention of a philosopher.[1]

Archimedes far exceeded all other men of ancient times in mechanical ingenuity. He was familiar with the doctrine of specific gravity, and practically applied it in detecting the fraud of King Hieros' jeweller, in debasing the crown. When Marcellus besieged Syracuse, Archimedes, from the walls of that city, raised out of the water and destroyed the hostile galleys, or hurled great stones into and sunk their ships; and by means of mirrors he so concentrated the rays of the sun as to burn the fleets of the enemy at a distance. So highly was this man esteemed for his mechanical construction, that, when Syracuse was taken and sacked, his house alone was ordered by Marcellus to be spared. And yet, such at that time was the disposition of philosophy towards the mechanic arts, that Archimedes expressed himself ashamed of these great works; and it was with difficulty that he could be persuaded to divert his mind to them, from mere speculations and abstractions. He regarded his great mechanical works as trifles, with which a mathematican was permitted only to amuse himself.[2]

A distinguished writer, in the time of Cicero, once ventured to enumerate among the humble blessings which mankind owed to philosophy, the discovery of the principle of the arch, and the introduction of the use of metals. Seneca regarded this as an *insult* to philosophy, repelled it, and indignantly replied to him that philosophy had nothing to do with teaching men to rear arched roofs over their heads; the true philosopher does not care whether he has an arched roof or any other roof; to impute to a philosopher any share in the invention of a plough, a ship, or a mill, is an insult.[3]

Such being the state of ancient philosophy, it is not to be wondered at that, for nearly six thousand years, the mechanic arts, despised and neglected, made but small advances. While Greece and Rome, in poetry, eloquence, statuary, and painting, attained to a degree of perfection unsurpassed in modern times, their mechanic arts remained almost stationary. Homer and Virgil are models for the poets of the present day. Men still revert to the glorious age of Athenian eloquence. The fame of Phidias, the sculptor, and of Apelles, the painter, have survived the shock of time which has destroyed the canvas and crumbled the marble. But the natural philosophy of Aristotle and Plato vanished before the light of modern science as suddenly as their moral theories did before the blaze of Christianity.

The human mind was misled by this false doctrine of philosophy until the close of the 16th century. It was then for ever overthrown and demolished by Bacon. He taught a new doctrine. He exhorted men to consider the true end of knowledge, and not to seek it for the gratification of their minds, or for disputation, or that they may despise others, or for emolument, or for fame or power, or such *low objects*; but for its *intrinsic merits* and the *purposes of life*. "The greatest error of all the rest," he said, "is the mistaking or misplacing the last or furthest end of knowledge, for men have entered into a desire of learning and knowledge; sometimes, upon a natural curiosity and inquisitive appetite; sometimes, for ornament and reputation; sometimes, for victory of art and contradiction; seldom, sincerely to give a true account of their gift of reason to the benefit and use of men......But it is that which will, indeed, dignify and exalt knowledge, if contemplation and action may be more nearly and straitly conjoined and united together."[4]

From Bacon, men first learned that science and the arts should walk hand in hand together, and since his day they have so journeyed. The good of mankind, thenceforth, became the aim of Philosophy. Deep was the root which the new doctrine took in the minds of men, and from it has grown the tree of modern science.

Bacon died in 1626. The tumults and troubles of the reign of Charles I., the revolution of 1642, and the disorders which ensued, for a time delayed the progress of science; but immediately after the restoration, in 1660, it began to advance with rapid strides.

About the year 1660, the Royal Society commenced its operations. This Society was originally founded directly upon the motto and the philosophy of Bacon.[5] The earliest records we have of its sessions date in the year 1664, and these show that much attention was given by it to the mechanic arts. During the very first year of its existence, one member was directed to bring in an account of iron from the ore to the bar; another, to inquire into the manufacture of hats; another into the making of lead; a fourth, delivered a full and elaborate report on the history of the manufacture of cloth, as then in use. Tracts were read on the art of marbling paper, and on the refining of gold. Much of the time of the Society, however, was devoted to researches in agriculture and medicine, which had been also neglected under the old philosophy.

The barbarous state in which science had been left by the alchemists, greatly embarrassed their early investigations. Many fables and falsehoods had been bound up with a little true knowledge, and a large portion of their time was occupied in investigating subjects which now excite our ridicule when mentioned. Thus, their recorded transactions inform us that on one occasion a member was ordered to provide some fresh hazel-sticks to try the experiment vulgarly called the divining-rod. Another member was subsequently ordered to bring his box of little animals called the death-watch; and at the next meeting, there were accordingly produced before the Academy two of these for inspection and experiment.

On the 5th of June, the Duke of Buckingham was enrolled a member, and presented a piece of unicorn's horn. The Society proceeded to try an experiment with it, recorded in the minutes as follows: "A circle was made with powder of unicorn's horn, and a spider set in the middle of it, but it immediately ran out. The trial being repeated several times, the spider once made some stay on the powder."[6]

The instrumental collection of the Society appears, during the first year, to have been limited, showing the low state of experimental science at that day. An air-pump, presented by Boyle, a rude microscope, and a loadstone, seem to have comprised their collection. With these, however, they conducted a great variety of experiments. Every thing that was deemed worthy of investigation was either placed under the air-pump, or was submitted to the microscope. The Academy were, nevertheless, proud of their instruments; their experiments were tried with great solemnity, and foreign ambassadors and princes were taken with pomp to see them.[7] Two mechanical inventions were before the Academy that year. One was the scheme of an improved engine for carriage, of such a one as goes by one wheel, and is drawn by one horse. The Society ordered a model made of it, and at the next meeting was produced the modern wheel-barrow made in pasteboard. The second invention was a bow-gun for shooting whales, subsequently abandoned. During the same year, information was received as to the state of one of the arts in the American colonies, then in their infancy. The process reported upon has probably been lost in the lapse of years; it was the art of killing rattlesnakes in Virginia. The outline of this process is thus recorded: "Some leaves of the wild pennyroyal were bruised, and these were tied in the cleft of a long stick; this was then held to the nose of the rattlesnake, who, by turning and wriggling, laboured as much as he could to avoid it; but he was killed with it in less than half an hour; and, as was supposed, by the scent thereof."[8]

At the same meetings at which these, to us, apparently so trivial subjects were discussed, investigations were presented which resulted in our present form of the barometer, in a portion of our present theory of heat and cold, and in improved modes of making lenses. This, too, it will be remembered, was only six years before the immortal Newton, in the 23rd year of his age, communicated to the Society his theory of light, and commenced that brilliant career which during sixty years shed such lustre upon their proceedings.

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[1] Plutarch's Life of Marcellus. [2] Plutarch's Life of Archimedes and Marcellus.
[3] Seneca's Epistles. [4] Bacon.—"Advancement of Learning," 174.
[5] The Royal Society was an attempt to reduce to practice Bacon's fiction of the New Atlantis. The influence of Bacon was not limited to England—it extended to France, and eventually throughout the Continent. In 1621, Bacon corresponded with Beranzon, an eminent professor in Savoy, in reference to his project for scientific investigation and discovery. And Descartes, who was one of the original founders of the French Association, the basis of the present National Institute of France, shows by his letters to Mersenne, in 1642, that he was familiar with, and entertained the most profound respect for the works of Bacon.
[6] Birch's History of the Royal Society, pp. 26, 84, 270, 338.
[7] Macaulay tells us, that Chief Justice Hale and Lord-keeper Guilford stole a portion of time from their judicial labours, to write treatises on hydrostatics. King Charles spent much time in his laboratory at Whitehall. "It was almost necessary to the character of a fine gentleman to have something to say about air-pumps and telescopes; and even fine ladies, now and then, thought it becoming to affect a taste for science, went in coaches-and-six to visit the Gresham curiosities, and broke forth into cries of delight at finding that a magnet really attracted a needle, and that a microscope really made a fly look as large as a sparrow." Macaulay, Hist. of England, p. 380. Pepy's Diary, May 30, 1667. [8] Transactions Royal Society, No. 3, p. 43.

From our present height of science, we can look back and behold these pioneers clearing the plain below, now gradually surmounting the obstaclès in their course, now wandering backwards for a space, oft-times delayed by the accumulated rubbish of old philosophy, but still steadily advancing, having truth—real, substantial, beneficial truth—for their object, and the omnipotent philosophy of induction for their guiding strength; until, in the lapse of time, we behold their Gregory, Davy, Wollaston, Cavendish, Brewster, Daniels, Faraday, and their compeers, fixing the utmost verge of earth for their bounds; and Newton and Herschel, the highest heavens for their resting-place.

The Royal Society subsequently devoted its attention more especially to the advancement of science, as distinguished from its application to the useful arts, and there sprung up in London, about a hundred years ago, another society, formed for the purpose of effecting a more direct union of science and art. That society was arranged much upon the same general plan as the Franklin Institute. It had its library, collections of models and machines, distributed premiums for inventions, improvements, and superior workmanship; and for nearly seventy years has published an annual volume of transactions. It was the first society which thus brought home to the practical mechanic the means of intellectual improvement in his profession. By its agency the position of mechanics was elevated in England, and the arts greatly advanced. This society arose at a fortunate era in the history of the Mechanic Arts—the era of the steam-engine. At that time James Watt was fifteen years old; fourteen years afterwards he gave to the world his immortal discovery.

And here let me remind you how far he thus contributed, beyond all other men, to the lasting comfort, happiness and glory of his race. In 1769 he converted a simple fire-pump into an engine of boundless power. Nearly a hundred years have elapsed since then, and yet it remains, substantially, unchanged. For eighty years that engine has toiled with the strength of millions of horses, for all men, in every land. Above the wreck of electro-magnetic and hot-air engines, the fame of James Watt, in undiminished splendour, towers proudly eminent. To his genius the hundreds of thousands of our fellow-men in the manufactories of Great Britain, France, and Germany, owe their daily bread; on every navigable river, lake, and sea, on the mountain top and in the deep mine, his engine is working out man's purposes. It has caused towns and cities to spring up and flourish on the barren rocks of New England; it melts, pounds, and rolls the iron of Pennsylvania, and gladdens our ears with the hum of a hundred workshops. It has given to the South a world-wide and insatiable market for its staple; it has filled the Valley of the Mississippi with vigorous life and abundant wealth, carrying its harvests to the East, and bringing back in return the products of manufacture and the rich spoils of commerce. The iron-road, which is but its pathway when it moves upon the earth, binds together the people of our thirty-one States by a tie as strong as our Federal Constitution. To that engine the works of Arkwright, Fulton, Fitch, and Whitney owe the exigency which brought them forth, and the energy which gave them life. Itself the greatest of inventions, it has called forth the highest ingenuity in others. Itself the strongest of mechanical powers, it has rendered available the greatest human strength. If Bacon gave to science the word of truth, Watt gave to art the arm of power.

Fidelity to my subject would require me to trace the organisation of associations similar to the Royal Society throughout Europe; to narrate how the great Colbert, at the instigation of Louis XIV., founded in 1666 the Academy of France; that Society which, in the words of David Brewster, "has stood unshaken and active amid all the revolutions and convulsions which so long agitated that noble, but distracted country; a common centre of affection, to which antagonistic opinions, rival interests, and dissevered hearts have peacefully converged." It would further be my duty to show how, in rapid succession, there sprung up at St. Petersburg, at Stockholm, at Berlin, Edinburgh, Dublin, Copenhagen, Brussels, and Turin, similar academic bodies, bright towers of science, whose light illumined the whole continent, and was, in time, reflected back by many stately halls reared to industrial art. Passing thence to our own country, and later days, I should call to mind the origin of the the American Philosophical Society, and the establishment of our own Institute in 1824; her early struggles, her subsequent prosperity, and how, for thirty years, she has laboured strenuously to unite the interests of the professor and the mechanic. The distinguished success achieved by many of her members—by many, whose presence here forbids my further speaking of them—her reported experiments on water-wheels, on boiler explosions, on the strength of metals, and others in high repute throughout the scientific world, her large library, her crowded exhibitions, and her able Journal, testify how faithfully she has carried out the purposes for which she was organised.

I fear, however, that this detail would become tedious to you; the encouragement of mechanic arts through the medium of Exhibitions, demands, moreover, a brief attention.

The Marquis d'Aveze was appointed Commissioner of Royal Manufactories in France, in 1797. He found that two years of neglect had reduced the workmen almost to starvation, and he then conceived the idea of converting the Chateau of St. Cloud into a bazaar, for the exhibition and disposal by lottery of the tapestry, china, and carpets, unsold and stored in the warehouses of the principal manufactories. A decree of the Directory, in the same year, however banished him along with other nobles from France. He was permitted to return in the succeeding year, and then carried out his original plan at the Maison d'Orsay. The project was eminently successful, and attracted the notice of the French government. That government then erected a Temple of Industry, which was filled with the most beautiful manufactured objects of France. On that occasion the practice of determining the relative merit of contributors and of distributing prizes by committees, originated. This exhibition was so successful that it was determined to repeat it annually.

The troubles of the French nation delayed its repetition until 1801; the third was held in 1802; the fourth in 1806. The wars of France delayed the fifth until 1819. Six others succeeded at intervals of five years, the eleventh exhibition having taken place in 1849, in the Champs Elysée. To their popularity is the origin of the Society of Encouragement to be traced—a society similar to our own, founded about 1804, and which has greatly promoted French art and manufacture.[9]

These exhibitions, it will be remembered, were all carried on by the government. The attention of the "British Society of Arts" was directed to the importance of the subject, about 1847, when their first public display was made. The Franklin Institute gave its first exposition of American manufactures in 1824.

Thus, it will be seen that this Institute is entitled to the merit of being the first society in this country, and probably in the world, which, by its own unaided resources, established this great fostering agent of the mechanic arts. Her example has since been followed by societies at New York, Boston, Manchester, Leeds, Dublin, Baltimore, and Washington. Like the associations from which they spring, they are now generally considered as the necessary incident and legitimate exponent of every manufacturing and mechanical community.

It is to the Society of Arts, of London, whose origin and early history we have already traced, that the world is indebted for an exhibition in which the mechanical industry of all nations was represented. The design of the great fair of 1851, at Hyde-park, was intrusted to a local committee of that Institute, in June 1848; and, after great exertion, they succeeded, with the aid of Prince Albert and the Royal Commissioners, in completing their work on the 1st of May 1851. That exhibition was but a development of our own annual expositions; yet, when we regard its extent, magnificence, and results, it cannot but be viewed as the most remarkable event of modern times.

A space of nineteen acres in Hyde-park was inclosed, and covered by a building 1848 feet long by 408 feet wide, and 108 feet high in the centre. The cost of this structure was 713,900 dollars. The value of the articles exhibited was about twelve millions of dollars. Forty nations contributed to the exhibition, and over six millions of people visited it. From Norway, on the north, down to the Cape of Good Hope, on the south; from China, in the east, to Chili, in the west; from ancient India and Egypt; from Moslem Turkey; from Guinea, on the coast of Africa; from New Zealand, in the South Pacific; and from the solitary Isle of Malta, they were there. *Then*, for the first time, was witnessed the spectacle of ships of war discharged of their armaments, and converted into transports of the mechanic arts. *There*, for the first time in the history of the world, the authorised representatives of thirty nations were assembled on a foreign soil, commissioned on no hostile errand, on no ordinary diplo-

[9] London Art Journal. 1851.

macy. There, for the first time since the Crusades, were the nations of Europe allied together for a purpose which religion deemed worthy of its sanction.

Surely, it seemed that the sword was about to be beaten into the ploughshare, and the art of war to be no longer learned by men. When the Royal Commissioners resigned their commission at the inauguration, the chairman announced the object of their work to be to conduce to the common interests of the human race, by encouraging the arts of peace and industry, and strengthening the bonds of union among the nations of the earth; and to promote a friendly and honourable rivalry in the useful exercise of those faculties which have been conferred by a beneficent providence for the good and the happiness of mankind.[10]

Thus we have seen how science and art, united together, have in times past advanced. Let us turn to the future. A striking lesson which the progress of the arts at the present day teaches us is the high social position which those engaged in mechanical pursuits are assuming throughout the world. As illustrative of this, I need only refer to the fact, that in France the medals awarded to Frenchmen at the Hyde-park Exhibition were distributed by Louis Napoleon in person; and the decoration of the Legion of Honour conferred upon the most successful exhibitors. The Grand Duke of Tuscany has recently, with great pomp and ceremony, established a new order of honour, called the order of "Industry." And aristocratic England has at length discovered that it is high time to abolish the distinction between the industrial and the so-called learned professions. An eminent Fellow of the Royal Society lately held this language: "Industry, to which England owes her success among nations, has never been raised to the rank of a profession. For her sons there are no honours—no recognised or social position. The restriction of learned honours to three recognised professions has a lamentable effect both on the progress of science and industry. Its consequence is, that each profession becomes glutted with ambitious aspirants, who, finding a greater supply than demand, sink into subordinate positions, becoming soured and disappointed, and therefore dangerous to the community. Raise industry to the rank of a profession; give to your industrial universities the power of granting degrees involving high social recognition to those who attain them, and you will draw off the excess of those talented men to whom the Church, the Bar, and Medicine, afford only a slender chance of attaining eminence."[11]

American mechanics, however, need neither legions of honour, orders of industry, or learned titles. The position which they may attain was fixed at an early day. It was fixed when the Philadelphia printer, in 1776, sat with Jefferson and three others to draft the Declaration of Independence; when the same printer signed the treaty of 1778, by which, for the first time, America was recognised as a nation of the earth; when, amid the splendour of the French Court, kings, royal beauties, and learned savans vied with each other in doing homage to the same printer —the conqueror of the forked lightning—our own Franklin. American mechanics know how largely they have contributed to the formation, wealth, and prosperity of this republic; that the want of a government which should protect and render uniform their interests, was a main cause of the adoption of the present constitution; that from that time down to the present their interests have given rise to our great national questions, our division of parties, and have elicited the highest eloquence of our statesmen. They know that the genius of this government, which recognises no titled distinctions, will accord to the exertions of their right arms, and of their intellects, their full meed of social reward.

Another no less striking lesson taught us is the conflict going on throughout the world for precedence in the mechanic arts; and that those nations which would win the struggle must render science more and more subservient to art—that practice and science must join together in a more solemn union. England was forced to admit that France had beaten her, and on her own soil. Eminent Englishmen conceded that France had surpassed them in the display of mechanic arts at Hyde-park. No sensible man doubts where the cause of France's victory lies. That it lies in her Central College of Arts and Manufactures at Paris, in her School of Mines, in her Conservatory of Arts and Manufactures, and in her Industrial Colleges at Ange, at Chalons, and at Aix, where hundreds, nay, thousands, of the most intelligent French youth are annually educated in the practical application of science to the mechanic arts and manufactures. The nations of Europe have looked to this with deep anxiety, and are rousing themselves to the contest.

England thus speaks by Playfair, one of her Commissioners at the Exhibition of 1851: "All European nations, except England, have recognised the fact that industry must, in future, be supported, not by a competition of local advantages, but by a competition of intellect. Their thinking men have proclaimed it; their Governments have adopted it as a principle of State, and every town has now its schools, in which are taught the scientific principles involved in manufactures; while each metropolis rejoices in an Industrial University, teaching how to use the alphabet of science in reading manufactures aright. Were there any effects observed in the Exhibition from this intellectual training of their industrial population? The official reserve necessarily imposed upon me as the Commissioner appointed to aid the Queen need exist no longer; and from my personal conviction, I answer without qualification in the affirmative. The result of the Exhibition was one that England may well be startled at. Wherever, and that implies almost every manufacture, science or art was involved as an element of progress, we saw, as an inevitable law, that the nation which most cultivated them was in the ascendant. Our manufacturers were justly astonished at seeing most of the foreign countries rapidly approaching and sometimes excelling us, in manufactures, our own by hereditary and traditional right."[12]

The illustrious Liebig proclaims from the continent, "that the great desideratum of the present age is practically manifested in the establishment of schools, in which the natural sciences occupy the most prominent place in the course of instruction. From these schools a more vigorous generation will come forth, powerful in understanding, qualified to appreciate and to accomplish all that is truly great, and to bring forth fruits of universal usefulness. Through them the resources, the wealth, and the strength of empires will be incalculably increased."

The venerable Humboldt, with almost inspired authority, thus counsels:—"The most superficial glance at the present condition of European states shows that those nations which linger in the race cannot hope to escape the partial diminution, and perhaps final annihilation of their resources. It is with nations as with nature, which, according to a happy expression of Goethe, knows no pause in ever-increasing movement, development and production—a curse ever cleaving to standing still. Nothing but serious occupation with chemistry and natural and physical science can defend a state from the consequences of competition. Science and information are the joy and the justification of mankind. They form the springs of a nation's wealth, being often, indeed, substitutes for those material riches which nature has in many cases distributed with so partial a hand; those nations which remain behind in manufacturing activity, by neglecting the practical application of the mechanical arts, and of industrial chemistry, to the transmission, growth, or manufacture of raw materials; those nations, among whom respect for such activity does not pervade all classes, must inevitably fall from any prosperity they may have attained, and this, by so much the more certainly and speedily, as neighbouring states instinct with the power of youthful renovation, in which science and the arts of industry operate to lend each other mutual assistance, are seen pressing forward in the race."

In this great struggle between the nations of the earth, what position are American mechanics to assume? Will they scorn these admonitions, and disregard these lessons of experience? Will they not rather call upon science to gird up her loins, and to strike for them in the battle?

In what manner the colleges and schools of our country have been, or may now be, accommodating themselves to this new state of things, it would be presumption in me to say. But I may be excused, perhaps, in addressing a word to the men of my own age, and to younger men, on the facilities afforded by the organisation of this Institute to carry out the principles of the great mechanical progress going on around us.

Elementary science, the practical development of scientific principles in organised machines and processes, and prompt information as to the advancement of scientific discovery, here and abroad, constitute the proper basis of study for the formation of mechanical intellect. To provide these, the organisation and re-

[10] Official Report of Royal Commissioners, at opening of Great Exhibition.

[11] Tract 'On the National Importance of Studying Abstract Science, with a view to the Healthy Progress of Industry, by Lyon Playfair.'

[12] Lectures before the Society of Arts, on results of Exhibition of 1851.

sources of the Franklin Institute are amply sufficient. Its annual course of lectures on elementary science, by professors of acknowledged ability; its large collection of treatises on theoretical and applied science; its committee meetings of learned professors, of experienced practical mechanics, of engineers skilled in mining and metallurgy, of practical chemists, versed in the processes of the arts; its monthly receipt of the scientific journals of this country and of Europe, and its own monthly journal and review —these are its means of usefulness, and to all these the members of the Institute have free access. If the words of Playfair, Liebig, and Humboldt be true, if our daily experience and if our common sense do not deceive us, a proper use of such means cannot fail to advance the mechanical intellect of our community, and better fit us for the great national conflict, now and hereafter to be witnessed.

To all who are interested in the progress of the arts and manufactures of our country, the eloquent appeal of Sir Humphrey Davy addresses itself with force: "You have excelled all other people in the products of industry. But why? Because you have assisted industry by science. Do not regard as indifferent what is your true and greatest glory. Except in these respects, in what are you superior to Athens and Rome? Do you carry away from them the palm in literature and the fine arts? Do you not rather glory, and justly, too, in being, in these respects, their imitators? Is it not demonstrated by the nature of your system of public education and by your popular amusements? In what, then, are you their superiors? In everything connected with physical science, with the experimental arts. These are your characteristics. Do not neglect them. You have a Newton, who is the glory, not only of your own country, but of the human race. You have a Bacon, whose precepts may still be attended to with advantage."

We have a Franklin. He trod the path of Bacon and of Newton; he reached the same pre-eminence. Amid his daily toil as a mechanic, he struggled up the steep ascent of science. The labour of his hands abated not the vigour of his intellect. Loiter not in the path which these great men have opened, lest you be overtaken and vanquished in the strife. Say, rather, that their precepts shall be attended to, and their example followed.

## VULCANISED INDIA-RUBBER RAILWAY-CARRIAGE SPRINGS.

G. Spencer, *Patentee.*

(*With Engravings, Plates* IX. *and* X.)

Our engravings represent a new system of applying vulcanised india-rubber to every description of railway-spring, in which are some features that we think worthy the attention of our scientific friends. We add some particulars of the advantages claimed by the patentee for these springs, together with a descriptive reference to the drawings, which have been furnished by Messrs. Reade, Spencer, and Co., of Cannon-street West, the sole manufacturers of them.

The chief advantages claimed for these springs over those in present use, are—1. Non-liability to get out of order, from their strength and simplicity of construction, and the peculiar fitness of india-rubber as a material for springs (when scientifically applied), to resist the effect of sudden concussions. These springs have been put to very severe tests by means of two powerful testing-machines, which the manufacturers have had constructed for that purpose. By means of one of them, a number of the india-rubber cones have been submitted to very great pressures, and left for a considerable time under pressure; but they were found on removal instantly to resume their original shape, and to be uninjured, and that in all temperatures. The cones used in these springs are equal to a force of five tons, but the power can be increased, if thought desirable, without any addition to the cost. By the second machine, worked by a steam-engine, 100,000 strokes have been given to several of the cones, without producing the slightest injurious effect upon them.

2nd. Extreme lightness in comparison with the springs in present use, by which means a great saving in non-paying weight is effected. Below is shown the comparative weight of the buffer-springs in present use on the carriages on the North-Western Railway, and that of buffer-springs on George Spencer's system:—

| | cwt. | qr. | lb. |
|---|---|---|---|
| Buffer-springs on North-Western Railway, including steel-plates, all iron work used with same, 4 buffer rods, buffer-blocks, plates, buffer-heads and fastening-guides, &c. Total weight .......................... | 10 | 2 | 6 |
| Buffer-springs on North-Western Railway, on George Spencer's plan, including india-rubber springs, 4 buffer-rods, blocks, heads, balls, and fastenings complete. Total weight ................................. | 4 | 1 | 14 |
| Saving of weight in this case ........... | 6 | 0 | 20 |

The total weight of Spencer's set of buffers and springs complete, being only that of the steel in the two springs on the old system, namely, 4 cwt. 1 qr. 14 lb., thus the weight of six passengers is saved in every carriage fitted with these springs, or of sixty in a train of ten carriages.

In the bearing-springs a further considerable saving of weight is effected; the weight of one bearing-spring complete, with all its parts, being only 33 lb. while those on the old system weigh three times, and sometimes four times as much. But a still greater advantage than saving of weight is effected by these springs,—"*they cannot break*," as laminated springs frequently do.

3rd. There is a great saving in the first cost of these springs over all others, owing to their extreme simplicity, and the cheapness of the material used.

4th. Owing to the small space they occupy in the under-frames of the carriages, these springs (buffers) may be in all cases used inside the framing, and thus any length of stroke may be obtained. The manufacturers supply several good and cheap forms of outside buffers (see figs. 1, 2, and 3), of the same powers (5 tons); but they expect that the many advantages possessed by inside-buffers will be a strong inducement to engineers and railway companies to adopt them, notwithstanding the small extra cost of these latter over the former.

These springs have met with very general approbation from the profession, and several eminent railway-carriage builders, both in England and on the continent, to whom they have been submitted, and from whom have been received very flattering testimonials of the merits of the invention, as well as large orders for their application.

*Description of Plates* IX. *and* X.

Plate IX.—Fig. 1 shows a new system of outside buffer of a a very effective kind for use on wagons and trucks; they are shown to a 3-inch stroke, and exert a power equal to five tons when driven home; C, is a corrugated cast-iron block; B, is a strong cast-iron piston; A, A, are the double cones of vulcanised india-rubber; *a*, *a*, are the confining-rings. Fig. 2 is a similar outside buffer, with the buffer-block made of elm. Fig. 3 shows a plan and elevation of an inside truck-buffer; B, buffer-rod; A, india-rubber cone; *a*, confining-rings; C, buffer-block.

Plate X.—Fig. 4 shows a plan of a spring for passenger-carriages. Fig. 5 a new system of bearing-spring. Fig. 6 a double-action draw-spring. Fig. 7 a single-action draw-spring.

## REVIEWS.

*The Museum of Science and Art.* Edited by Dr. Lardner. London: Walton and Maberly. 1854.

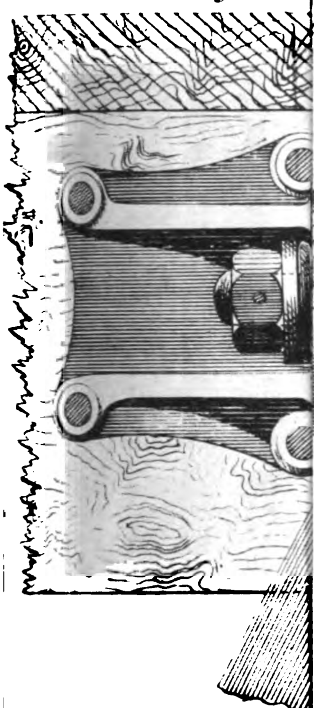
The purpose of Dr. Lardner is, he states, to publish a collection of instructive and amusing essays and tracts in a popular and amusing style, on the leading discoveries in the physical sciences, and on their most important and interesting applications to the industrial arts. In this design he does not address himself simply to the uninstructed, but also to those who have been disciplined in the study of the sciences. We think it a very useful feature, that the writer proposes to avail himself of many interesting and familiar details and incidents, which are usually excluded from systematic treatises. The work, too, is to be published in a very cheap form, so that it may be obtained in penny numbers. To conduct such an enterprise, we know no one more fitting than Dr. Lardner. He is as much of a student as a professor; indeed, for part of his life he taught what he had learned only a few hours before. Thus he shows in his writings a full knowledge of the wants of the student; he follows his train of thought, he meets the difficulties that arise, and makes ready the way before him. To the young and to the old reader such a guide is valuable, for the former wants assistance to compass a

RIAGE SPRINGS. *Plate 9.*

*est, London*

**INSIDE WAGON O**

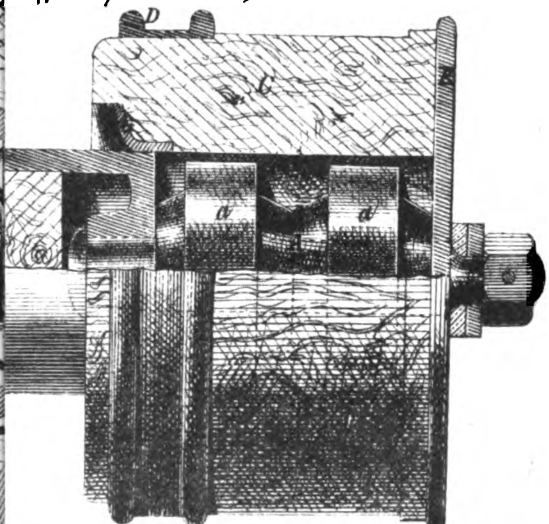
*Fig 3. El*



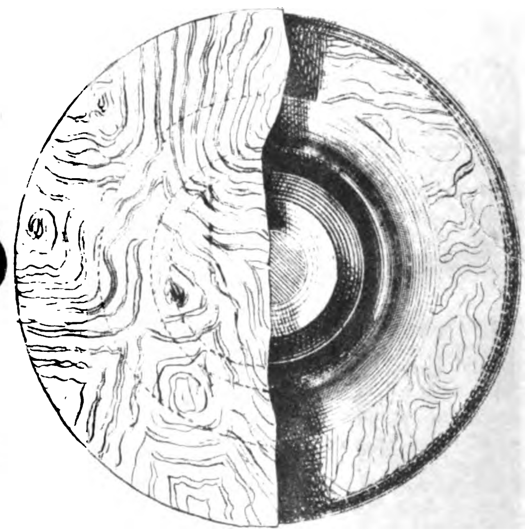
**OUTSIDE BUFFERS ( 3 inch STROKE)**

*Fig 2.*

*on (partly in Section)*



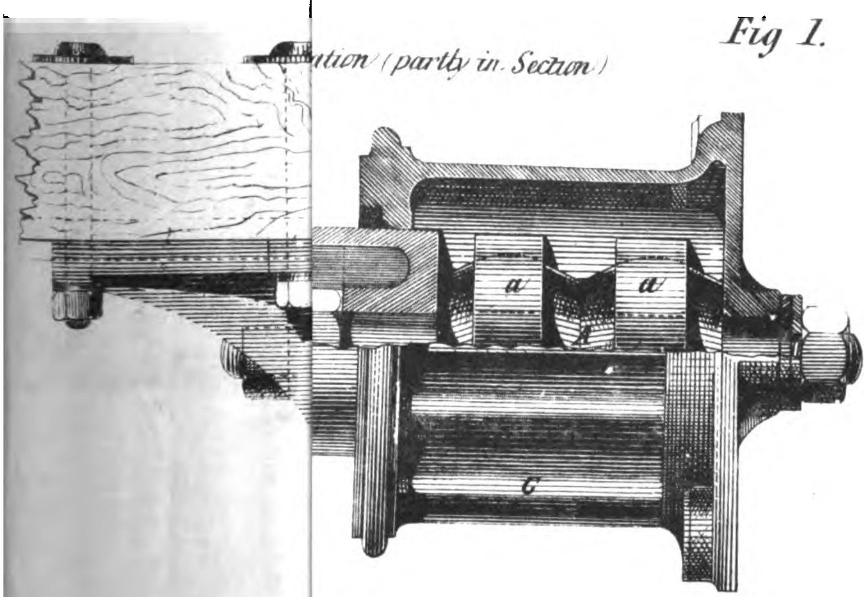

*End Elevation (partly in Section)*



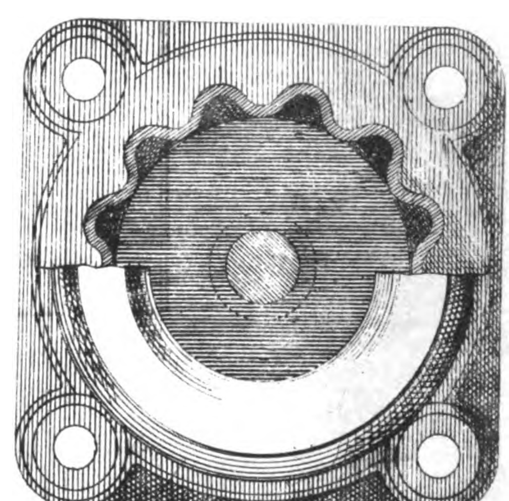
*Scale, 3, Inches to 1 Foot.*

*Fig 1.*

*ation (partly in Section)*




*End Elevation (partly in Section)*



M. Corn Litho, 15 Cheapside

new subject, the latter too often needs time to wade through or to elaborate a treatise artificially constructed.

If we are to judge by the first part, the Doctor's description does not do justice to all the merits of his design. This part includes two subjects: "The Planets, are they Inhabited Worlds?" and "Popular Fallacies,"—which, independently of their application, are interesting as illustrations of modes of reasoning, and will be found valuable to the professional student who may have been trained solely in the mathematical process, or only mastered the schemes of the logicians. In the first paper physical facts are made use of in the solution of a moral problem, and applied, by way of analogy, to indicate results. This is a mode of reasoning wanting the rigidity of the mathematical process, but one which is alone available in many cases, and which is of much application in the affairs of life. In the paper called Popular Fallacies, the writer shows that what is called the evidence of the senses is liable to error, and must be subjected in many cases to correction. We call attention to these features because, in the present day, the practice is too prevalent of teaching facts without teaching the mode of reasoning, and of imposing a very extensive course of instruction which includes everything but the art of thinking. We believe the University of London is the only examining board where the medical man undergoes an examination on logic; and, we believe, nowhere else is there such an examination or instruction for the lawyer, who is supposed, above all others, to exercise a profession dependent on dialectics.

The question—"The Planets, are they Inhabited?"—is examined by the light of all those phenomena which the latest and soundest observations have established, and the author endeavours to show that the harmony of conditions of the several planets, as compared with the earth, is in favour of a similar organisation. In developing this from a variety of facts, some interesting examples of analysis are exhibited, and suitable diagrams and illustrations are introduced to assist the reader. We think a more convenient course of arrangement would have been to have considered, first, the harmony of geological conditions; secondly, of botanical; and thirdly, of zoological conditions. Nevertheless, there is a harmony of results from the numerous solutions collected by the author.

In a paper on weather prognostics, Dr. Lardner analyses the evidence as to the supposed influence of the moon on the weather, and controverts the popular doctrine.

The number on Popular Fallacies is, more strictly speaking, an inquiry into errors of the senses; and this will afford an opportunity of giving an extract, which may serve to illustrate the author's mode of treating his subject.

"*Fallacies of Vision.*—Of all the organs, that which would seem to be most exact and unerring in its indications is the eye; and, although in a certain sense this is true, yet there are no impressions which more imperiously require the exercise of the judgment to adjust and rectify them than those of vision. By this sense, we receive the perception, subject however to many qualifying conditions of form, magnitude, brightness, and colour. There is not one of these qualities, however, which is not frequently mistaken or wrongly estimated.

"*Fallacies of Vision, as applied to the Sun and Moon*—Every one, for example, is familiar with the appearance of the sun and moon when rising and setting. The apparently large orb which they present to the senses is an object of familiar notice. Is not every one impressed with a conviction that the apparent magnitude of the sun when it rises, glowing with a redness acquired from the depth of air through which its rays then pass, is much greater than the apparent magnitude of the same object at noonday? and is not the same impression admitted with respect to the rising or setting full moon, compared with the same object seen on the meridian? Yet nothing is more easy to prove, as a matter of fact, that these impressions are fallacious. Let any one adopt any convenient method which may occur to him, to measure the apparent magnitude of the sun on the horizon, and again on the meridian, and he will find them the same. This may be accomplished by extending two threads of fine silk parallel to each other in a frame, and placing them in such a position, and at such a distance from the eye, that when presented to the sun or moon, on the horizon, they will exactly touch its upper and lower limb, so that their apparent distance asunder will be equal to the apparent diameter of the lunar or solar disc. If this arrangement be preserved, and the sun or moon be viewed in the same manner when at or near the meridian, it will be found that the threads will equally touch its upper and lower limbs, and that their interval will still measure its apparent diameter. It will therefore be evident, that whatever be the cause of the illusion, the apparent magnitude of the sun or moon is not greater at rising or setting than in the meridian. Whence, then, it may be asked, arises an impression so universally entertained?

"The explanation of this singular effect, in which all astronomers appear to concur, refers it to mental, and not optical causes; strictly speaking, it is not an optical illusion. The error is one of the mind, and not one of the senses. The estimate which we form of the actual magnitude of any visible object depends on a comparison of the apparent magnitude which that object presents to the eye, with the distance at which we imagine it to be. Thus, if there be two objects—buildings, for example—which have to the eye the same apparent height, but which we know or believe to be at different distances from us, we instinctively, and without any operation of the judgment of which we are conscious, conceive that which is more distant to be the largest.

"To apply this reasoning to the case of the sun or moon, we are to consider, that when either of these objects is in the horizon, a portion, at least, of the space between the eye and it is occupied by a series of objects, with the magnitudes and relative positions of which we are familiar. We are therefore enabled to make some estimate of a portion of the space that intervenes between the eye and the object. But when the object is in a more elevated position in the firmament, no part of the intervening distance is thus spaced out, and we are accustomed to consider the object nearer to the eye.

"Conceding this, then, it will be asked how it explains the universal impression of the enormously large disc of the sun or moon when rising or setting; the answer is, that when in or near the horizon, the mind is impressed with the idea that the distance of these objects is much greater than when on the meridian, and that their apparent magnitude being the same, the real magnitude is judged to be greater in the same proportion as the distance is supposed to be greater. Thus, if we are impressed with the notion that the sun seen in the horizon is twice as distant as the sun seen in the meridian, we shall infer its diameter to be twice as great, since it appears the same; and if its diameter is twice as great, its apparent superficial magnitude will be four times as great.

"The operations of the judgment in such cases are so rapid, and the effect of habit is such, that we are altogether unconscious of them. A thousand examples might be given of bodily actions and motions performed by the dictates of the will, of which we retain no consciousness. It is difficult, in the case we have just explained, for minds unaccustomed to metaphysical inquiries, to satisfy themselves of the validity of the explanations we have given. Yet, if it be remembered that it is capable of unequivocal proof that the illusion is not optical, and that, in fact, the apparent magnitudes of the moon on the horizon and the meridian are not different, it will easily follow that the error must be mental, and the only explanation which has ever been given of it is that which we have here offered.

"There is perhaps no sense which more requires the vigilant exercise of the understanding to rectify its impressions than that of sight. The susceptibility of the organ of vision itself is liable to frequent and rapid change, and the same objects at different times produce upon it extremely different impressions. A situation in which, in one condition of the eye, we shall appear to be in absolute darkness, will present to us, in another state of the organ, sufficient light to render visible the objects around us. If we are suddenly deprived of the illumination of any strong artificial light, we appear to be for the moment in absolute darkness; but when the organ of vision has had time to recover itself, we often find that there is sufficient light to guide us.

'Thus when the lamp that lighted
 The traveller at first goes out,
He feels awhile benighted,
 And lingers on in fear and doubt.
'But soon, the prospect clearing,
 In cloudless starlight on he treads,
And finds no lamp so cheering
 As that light which heaven sheds.'—Moore.

"*Perceptions of Colour.*—The perception we receive of the colour of an object depends often as much on the condition of the eye when the object is seen as upon the object itself. By the action of lights of different colours, the sensibility of the retina may be so modified that the same object will appear at different times to have different colours, and unreal objects will often be perceived. These are called spectra. If we place on a sheet of white paper a red wafer, and, illuminating it strongly, direct the eye steadily to it for a short time, and then look at the paper close beside it, we shall there see a blue wafer of the same size. This object is an optical spectrum. The cause of its appearance is easily explained. By the action of the strong red light proceeding from the wafer, the retina is rendered for the moment insensible to the operation of a more feeble red light upon it, for the same reason as the ear would be insensible to the ticking of a clock immediately after being affected by a discharge of artillery. Accordingly, when the eye, after viewing the red wafer looks at a white wafer beside it, the action of that portion of the compound white light reflected from the paper which is red, fails to produce any perception, and the remaining constituents alone are perceived, which accordingly present a blueish tint. To comprehend this and other similar illusions, it is very necessary to remember that white light is a compound of reds, yellows, and blues, and that if we deprive it of any one of these elements, it will assume the tint produced by the others. Thus, if the eye be insensible to red light, all white objects will appear to it with a tint composed of yellow and blue. If it be insensible to blue light, then white objects will appear orange.

"Instances have more than once occurred, and are recorded in the works on optics, of individuals incapable, from original defects of vision, of perceiving particular colours. The late Dr. Dalton, of Manchester, was a conspicuous example of this.

"But, as we have above stated, even a healthy and perfect eye will be rendered temporarily insensible to the impression of particular colours by being exposed for a short time to the strong action of coloured lights. Optical illusions are produced in this way in the exhibition of fireworks. When luminous balls, some red and some white, are thrown up into the air, the white appear blue beside the red, and are generally imagined to be really blue. The effect, however, is a visual illusion, ascribable to the cause just explained.

"In the sky, towards sunset, when reddish clouds are arranged with openings between them, the sky at such openings appears green, although it be really blue.

"In astronomical observations on the stars there is a curious case, in which it has never been settled whether the appearance is real or illusive. Many of the stars, which to the eye appear individual objects, prove to be double when examined with powerful telescopes. The two stars, thus composing a double star, are frequently of different colours, and it is found that when one is red the other is of a blueish tint. Now, we know that it would appear of this tint, even though it were a white object, by reason of the presence of the red star. Whether, in these cases of double stars, the blue one would be really blue, or is rendered so by the optical effect adverted to, has not been decided, it being impossible to view it except in juxtaposition with its red companion.

"*Fallacies as to Number.*—One of the most curious and most incomprehensible illusions of the senses is the singularly-erroneous estimate which we make of the number of objects of any kind that are presented to us. A striking example of this is presented by the impression made upon the eye by the view of the firmament on a clear starlight night. The number of visible stars is always immensely over-estimated. Although it be true that the stars are, strictly speaking, countless in number, yet the number distinctly seen by the naked eye at any one time, unaided by the telescope, is not great. Any one can satisfy himself of this by examining any good map of the stars; yet, when we look at the firmament on a clear night, these objects appear to be inconceivably numerous. This illusion is dispelled by examining the heavens through the most ordinary telescope, or even by looking through a long tube, which will limit the view at any one moment to a small portion of the firmament. On the entire sphere of the heavens there are not above twenty stars of the first magnitude, and it is seldom that as many as six or eight of these can be seen at once. The number of stars of the second magnitude does not exceed fifty, and of these twenty are seldom seen at any one time. The stars of the third magnitude may amount to about two hundred, half of which only can be at the same time above the horizon. The small stars are much more numerous, but they are discernible with difficulty, and do not produce upon the mind the impression of multitude that we conceive."

Unless the Doctor reserves it for another occasion, he might have said more about chromatopseudopsis, or Daltonism. Besides Dr. Dalton, we believe the eminent mathematician, John Herapath, was partially affected with colour-blindness. This imperfection of vision as regards colours, is one that interests engineers, on account of its unfavourable influence on those set to watch railway signals. There can be no doubt that, among the thousands of engine-drivers, stokers, guards, and other employees, many cases of the imperfect discrimination of colours must be found, and it is suspected that serious consequences have resulted from this defect. This physical evil is also worthy of consideration by another class of engineers, those connected with lighthouses: and is one reason for which coloured lights for such purposes are open to objection. The gas engineer has too, perhaps, something to learn with regard to the effect of illuminating substances of various colour.

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*The Human Hair, Physiologically Considered.* By ALEXANDER ROWLAND. London: Piper Brothers. 1853.

This work treats a novel and seemingly a trivial subject, but those who read it will find a mass of learning well applied, and that the volume is by no means too large for its complete treatment. We should, nevertheless, have left it to the physiologist were it not for the evidence it gives in favour of the endeavours now being made for the protection of men in various employments exposed to injury of the respiratory organs. The evidence adduced from theory and practice shows, conclusively, that the old English fashion of wearing the beard and moustaches is the natural and effective safeguard of the lungs, nostrils, and throat, not only against the influence of the external atmosphere, but against the injurious effects of various employments. It is indeed singular, that after the artificial and unnatural practice of shaving had taken root in this country, art was called in, by the application of the respirator, to remedy the evil. The Russians, who are exposed to a cold of 35° below zero, wear no other covering round the throat but the beard. It being found that the German and French masons are less subject to phthysis than ours, Professor Alison, of Edinburgh, recommended the masons of that city, on the score of health and cleanliness, to wear the beard and moustache as a preventative against breathing the fine dust, which so much injures the working-mason and shortens his life. We are informed that now nearly all the masons in Scotland, in the north of England, and parts of Ireland, and many in the south of England, have adopted this advice. It is noted that in Bavaria and Wurtemburg, in particular, where freestone is extensively worked, the masons are fine-looking muscular fellows, with large beards, and such a disease as phthysis is never heard of. The official medical statistics of our army show that the cavalry regiments suffer less from phthysis than the infantry. Steel-grinders, millers, cabinet-makers, and some other trades where dust is inhaled, are following the example of the masons. On many of the Scotch and some English railways, the engineers and guards, who are severely exposed to the weather, are directed to wear their beards, and in some towns the police. A curious practical example of the operation of the natural hair was observed by Mr. Chadwick, in the case of some blacksmiths who wore beard and moustaches, the hair about the mouth being discoloured by the iron dust that had been caught in its way into the mouth and lungs. It is said that the air-passages of a Londoner, or Manchester man, are found to be more or less coloured by the dirt that is breathed.

## RUSKINISM.

THE tide is beginning to turn against Ruskin; his popularity is now ebbing away very fast. The 'Stones of Venice,' and the 'Fall,' have occasioned his own downfall and tumble, and have lately incurred for him, in different quarters, a good deal of strongly-pointed animadversion, no less just than severe. In fact, he may now be said to be,

"Fallen, fallen, fallen
From his high estate;"

for his admirers—real or pretended—leave him in the lurch; no doubt, because conscious that it is impossible either to ignore or to refute the charges now brought against him by those who really do understand something of architecture, and have plainly convicted Ruskin of gross absurdities and inconsistencies, which they themselves were either too ignorant to discern, or else wilfully omitted to point out to their readers.

Abundant was the praise bestowed by reviewers on the 'Seven Lamps,' but with regard to quality it was little better than ordinary off-hand newspaper-puff, to the tune of,

"Long live the Regent and the Duke of York."

They lauded his "eloquence," his feeling, his fine passages fraught with imagination, and so forth, some of them expatiating upon his peculiar merits in that respect,—which at the best were but of secondary consideration,—in a style that seemed to mimic—at any rate to be ambitious of mimicking, his own. One of Ruskin's eulogisers assures us that his architectural writings "cannct be read by any one without improvement to his moral sense and mental discipline." Another has had the hardihood to predict that "'The Stones' will become the most popular of all his productions!" A third hails him as "the first really popular writer we have ever had upon architecture,—the first who has satisfactorily touched upon architectural principles." "His eloquence," says a fourth, "is as rich, his enthusiasm as hearty, his sympathy for all that is high and noble in art as keen as ever." Such is the strain in which pen-wielding donkey after donkey has brayed forth his rather clumsily-feigned raptures into which they profess to have been thrown by John Ruskin's double-distilled sentimentality, and lackadaisical palaver. The substance and ingredients of his books are, moreover, of very "mince-pie" sort, the most heterogeneous matters and topics being mixed up together in them; so that dipping into them at random, we might at one time fancy that we had taken up a volume of sermons; at another, that we had pitched upon some formal dissertation on painting; or else dipped into some work on Venetian history; or into some political treatise, some essay on morals. And in every instance we might read on, page after page, without discovering or even suspecting that such matter—of whichever sort it was—

was merely a long-winded *hors-d'œuvre* in what professes to treat specially of architecture. Not only does Mr. Ruskin touch on very irrelevant matters, but he dwells upon them so long that he frequently seems to forget architecture altogether; or else to make use of it as a mere peg on which he can hang up and display his own peculiar notions respecting things in general.

The consequence is his three bulky volumes ycleped 'The Stones of Venice,' must disappoint even those who are disposed to fall in with Ruskin's architectural fancies and heresies, when they find how very much there is crammed into them that does not relate to architecture at all, but serves only to swell out the work and add to its price, rendering the last almost a prohibitory one in these days of cheap literature. On the other hand, placed where it is, the non-architectural matter is completely buried from those whom it more immediately concerns and is likely to interest, or who, even if they are aware of its existence, will hardly purchase so extravagantly expensive a work, merely for the sake of such portions of it. Therefore, as far as sale is in question, Mr. Ruskin appears to have placed himself upon two stools; which is, however, his concern, not ours.

What he calls his "Topical Index" exhibits the multifariousness in which he indulges, and how much of the exceedingly far-fetched and incongruous he has foisted into his work, thereby rendering it chaotic, disjointed, and fragmentary. Digressions to the same extent might have been excused had they been confined to disquisition bearing more or less upon architecture itself. We are so overburthened with earnest, thoughtful, intelligent, searching, many-sided criticism on the subject of it, as to render any addition either unnecessary or unwelcome. We must not, however, look to Ruskin for it, he being a man of such extreme prejudices as better qualified for the office of a *hangman* than a judge. Neither does he show himself to be the most skilful of advocates; since after all, according to him, his idolised Venetian Gothic is the best style only because all others are decidedly bad and worthless, so "base," "detestable,"—such mere "clouts" and "rotten rags," that they deserve to be flung aside at once without examination. Therefore, instead of being represented as supreme among the noble and the glorious, it is made to appear little better than a mere *pis aller*.

More energetic than gentlemanly in the language he employs on that occasion, Ruskin shows himself also to be no less foolhardy than foul-mouthed, flying in the face of, and scornfully trampling upon, all established authority whether as regards theory and criticism, or practice. Singularly inconsistent he most certainly is, and not least of all so upon one most important point, for how is it possible to reconcile his professed abhorrence of Romanism with his love of symbolism and the practices of the unreformed mediæval church? Not only is he avowedly Pre-Raphaelite in his taste, but covertly Pre-Lutheran in his sentiments. When he charges the Renaissance period with infidelity he surely forgets that it was also that of the great Protestant Reformer,—forgets, too, that classical literature helped to dispel the superstitions of monkish lore. Now, his Pre-Raphaelitism and Pre-Lutheranism go well together, yet the latter is altogether at variance with the puritanical strictness he affects when touching upon matters of belief and religion; and he not only frequently touches, but sometimes dwells upon them in a very strange fashion.

That there is a very great deal in 'The Stones of Venice' that no one cares to countenance, is tolerably evident, there being a very great deal which even his admirers deem it advisable to take no notice of whatever, notwithstanding that much of it is not a little startling. A writer in Parker's 'National Miscellany' qualifies his commendation of "Mr. Ruskin's delightful book," by pointing out certain "defects," and among them a gross mistake relative to the Doge's Palace; but he winks at his depreciation of our English Gothic, his sneering at the towers of York Minster as no better than "confectioners' Gothic," and his rabid denunciation of the classical styles, both ancient and modern,—which reference surely partakes of dishonesty. Let those who really admire Ruskin, and are willing converts to his doctrine and teachings, show their sincerity by boldly standing up in defence of his vital and most vulnerable points; instead of which they deck him out with gaudy plumes, when they ought rather to supply him with an impenetrable breastplate.

CANDIDUS.

## RECENT AMERICAN PATENTS.

[Reported in the Journal of the Franklin Institute.]

*Method of Generating Steam.* J. B. Moinier and P. H. Boutigny.

The generator is formed so as to cause a direct production of steam at high temperatures (500° and upwards) by means of injecting water at the top or near the top of the generator, when the same is in a heated state, and causing the water to come in small quantities in contact with the surfaces of perforated metallic diaphragms (arranged one above another within the generator) and also to come in contact with the sides of the generator.

*Claim.*—Subdividing the water and at the same time increasing the evaporating surface of the generator, the water being gradually heated and subdivided in its passage through the apertures or meshes of the diaphragms, before it comes in contact with the more highly-heated surface of the generator.

*Steam Boilers.* B. Irving.

The improvements in this invention are, chiefly, to secure a more perfect combustion of the gases generated by the consumption of fuel, and to present a large extent of heating surface without subjecting any part of it, when working properly, to a very intense heat; to guard against explosions of the boiler; to gain more compactness and strength in structure, and to diminish the necessary weight of metal and quantity of water. The results claimed are, economy in amount of fuel and in expense of construction, safety from explosions, increased strength and durability, and adaptedness for the use of coal or wood to propel engines on railroads, and for all other purposes.

*Claims.*—1, a boiler composed of an external water-jacket, of cylindrical or other form, with a steam-chamber at the top, and with or without one or more inner water-jackets connected with the outer water-jackets, when either water-jacket contains one or more vertical coils of steam-pipe, whose lower ends connect with one of the water-jackets, and whose upper ends discharge into the steam-chamber; 2, drying the steam by passing it through a coil within or between the water-jackets.

*Regulating the Speed of Steam-Engines.* R. Fraught.

This invention consists in causing the "cut-off" valve to move with the slide-valve, by means of friction produced between them by the pressure of the steam in the valve-chest, and by plates compressed to the valve-rod by a spring, or by other suitable means. The "cut-off" is attached to a pendulum, or other contrivance, capable of offering to its movement a resistance which causes it to move a shorter distance than the valve, and thus close the steam-openings of the valve, and cut-off the steam before the termination of the stroke of the engine, and which resistance increases or diminishes with the increase or diminution of speed of the engine, so as to close the passages and cut-off the steam earlier or later, as may be required, and thus regulate the speed of the engine.

*Stoves.* T. S. Gore.

An inner cylinder or chamber of the stove is surrounded with spiral flues, so arranged or connected to the base that the heat which passes down the spiral flues will meet or unite with a main flue or pipe connected to the ordinary smoke-pipe. By this arrangement of the spiral flues and base, a large heating surface is obtained, and a space formed for the admission and heating of cold air.

*Apparatus for Purifying Gas.* W. Wigston.

This invention consists in what is termed a scrubber, which is a float of wood or other material, of circular or other form, of sufficient buoyancy to float in the purifying liquor, with an interior cavity above the surface of the liquor, and with passages leading from the said cavity through its sides, and the gas enters through the inlet pipe which rises through the liquor, and opens into the cavity above its surface, escaping through the passages through the sides. These passages are so arranged that they are almost or entirely submerged, when there is no pressure of gas; but that when there is a pressure, the float will be raised so as to bring a small portion above the surface, to allow the escape of the gas in very thin streams, to produce a diffused contact with the fluid.

*Machines for Making Railroad Chairs.* R. Griffith.

*Claim.*—1. Hanging the fulcra of the clipping and bending levers eccentrically in boxes made capable of circular movement, for the purpose of adjusting the said levers to their work with facility and accuracy. 2. A method described of adjusting the angular set of the clipping and bending levers, by pivoting and adjustably connecting them to outer operative levers, essentially as set forth, and whereby a varied inclination may be given to the cutting and bending of the clip, to suit different thicknesses of blanks or forms of chair required.

*Magneto-Electric Machines.* C. Carpenter, jun.

This invention consists in the combination of one or more series of permanent magnets, radially arranged; the poles of each series being in one plane, and in two concentric circles, with a disc or discs of helices arranged in three sets, in such manner that the three sets may be acted upon successively, at nearly equal intervals of time; one set by the inner circle of poles, and the other two sets by the outer circle of poles; the currents of the several sets of helices being thrown into one constant or uninterrupted current by means of the current dischargers and springs, or theire quivalents.

*Metallic Piston-Packing.* Henry L. Russell.

This invention consists in expanding a number of metallic bands which encompass a drum, by means of levers secured in the periphery of the drum, and operated upon by a ring within the drum. The ring is prevented from casual movement by means of a coil-spring, ratchet and pawl, or their equivalents.

*Machine for Dressing Stone.* E. G. Matthews.

This invention relates, firstly, to arranging the driving-wheel and friction-wheel, forming the cutting apparatus, in the frame attached to the driving-rod, by means of which rod a reciprocating motion is imparted to the frame, which causes the driving-wheel to rotate backwards and forwards, on and over the heads of the cutter-stocks, thereby causing the cutters to make the desired cut in the stone; the friction-wheel, meanwhile, rolling on the periphery of the driving-wheel, and also in a groove in the cross-bar. Secondly, combining the rocking-bar, which has inclined planes at each end, with the cutter-stocks and roller, or its mechanical equivalent, attached to the frame of the driving apparatus, for the purpose of rolling or striking on the inclined planes of the bar as the driving-apparatus reaches the end of its stroke, so as to rock or tip the bar, thereby causing the inner edge of the bar to catch or stroke under the shoulders in the cutter-stocks, and raise them up in position for the driving-wheel to act upon them on its return-stroke.

*Machine Hammers.* D. Noyes.

This invention consists in a novel arrangement of mechanical contrivances for hammering or forging iron, whereby it can be brought into any desired shape or form much more expeditiously, and with greater regularity, than by any of the modes commonly practised in trip-hammers for the purpose. This result is effected by means of hammers which are so placed and actuated as to strike the iron to be shaped, both on the top and on the two sides; the upper hammer having motion imparted to it from a crank on the main driving-shaft, and the two side-hammers moving horizontally so as to strike the sides of the piece to be forged.

*Claims.*—1. A hammer for giving the blow upon the upper surface of the iron, acting in conjunction with two hammers, which simultaneously strike the sides of the iron; these two side-hammers operating as specified, whether in connection with the upper hammer or without it. 2. So arranging the relative position of the fulcra of the hammer-beams, and the ends of the connecting-rods attached to these beams, and to the crank-shaft and gears from which they derive their motion, as to bring the said fulcra and connecting-rods in nearly a straight line at the time of giving the blow for the purpose specified; the opposite ends of the connecting-rods just before giving the blow, moving in opposite directions, so as to give a rapid and powerful blow. 3. Causing the anvil to descend from the iron just before the blow of the side-hammers, and to ascend just before the blow of the upper-hammer, by means of a rod attached at one end to the under-side of the hammer-beam, and at the other to a tilting-arm which embraces the anvil.

## INSTITUTION OF CIVIL ENGINEERS.

*Jan.* 10.—JAMES SIMPSON, President, in the Chair.

THE proceedings of the evening were commenced by an Address from the President, on taking the chair for the first time after his election. After expressing his sense of the distinction conferred on him, by his election to the post of President, he embraced the opportunity of acknowledging the debt of gratitude he, in common with many other members of the profession, owed to the Institution of Civil Engineers, where they had first found a field for the exhibition of their talents, and had there formed the valuable and lasting friendships to which might be attributed the good feeling prevalent in the profession. He then alluded to the difficulties formerly experienced by young engineers, at the commencement of their career, chiefly from want of opportunity of contact with, and experience of the proceedings of the older practitioners; contrasting it with their present freedom of communication with the seniors at the meetings of the Institution, where all met on a footing of equality and with a predisposition to afford the aid or advice that might be requested.

He then gave a slight sketch of the professional career of his father, who entered the metropolis as a millwright in 1778, and before his decease had raised himself to eminence as a civil engineer, and was the coadjutor of Smeaton, Jessop, Watt, Rennie, Telford, and others. Under him Mr. James Simpson commenced his practical career, of which he gave a rapid outline. As a very old member of the Institution, having been elected in 1825, and chosen a Member of Council in 1826, he ventured to give some sound practical advice on the subject of agitation in societies.

He then gave a succinct account of the great engineering works in progress in India, Egypt, Sweden, Norway, Denmark, Canada, Australia, Cuba,—on the European continent generally, and Russia; chiefly under the direction of Members of the Institution. The maritime works on the Thames, the Tyne, the Severn, the Clyde, the Avon, &c.—the harbours and docks at Harwich; at Dover, at Guernsey, Jersey, Alderney, Portland, Holyhead, Plymouth, Leith, Hartlepool, and other places; the works at the Norfolk Estuary, the reconstruction of Bishop's Rock Lighthouse, and other important labours of civil engineers, were also noticed.

He also alluded to the subject of screw propulsion, and the valuable and hitherto unrewarded labours of Mr. F. P. Smith, as triumphantly demonstrated in the late naval review at Spithead, and the general adoption of the system for an improved class of steam and sailing vessels. The new system of propulsion invented by Ruthven, and introduced by Mr. Clark, for the Deep-Sea Fishing Company, was also mentioned.

The improvements in the supplies of gas and water, particularly of the latter, were noticed, in contradiction to assertions made "by authority" that little or no amelioration had taken place. A short history of the waterworks of the metropolis was given, to show that the extensions and ameliorations of filtering and high service had closely followed the facility for obtaining cast-iron pipes, in large quantities and at a reasonable rate; and that the improvement in steam-engines and pumping machinery had also produced corresponding advantages.

Attention was directed to the present state of the sewerage of cities and towns, and also that of the drainage of farm lands; for the former it was urged, that more had been done than was generally admitted, and for the latter, the partial steps hitherto taken were contended to be inefficient, unless the system was introduced on a larger scale, and extended to arterial and trunk drainage, and the improvement of the principal drains and watercourses in the low-lands.

The regulations for the prevention of the nuisance of smoke from steam and other boilers were noticed, and the various trials already made were examined.

The present general employment of members of the profession was alluded to with pleasure, as demonstrating that the science and practice of engineering had not experienced any check; and with a tender, to the junior members of the Society, of any advice or assistance in his power, the President concluded his address, which was unanimously voted to be printed and published with the minutes of proceedings.

*Jan.* 17.—The discussion was renewed on Mr. Harrison's Paper, "On the Drainage of the District, South of the Thames" (*ante* p. 35). After reviewing the objections to the proposed main sewer of 8 feet diameter, and its tributaries or feeders, it was explained that the general dimensions had not been assumed as fixed, but only as data to argue upon; the practical area, as well as the ultimate direction, remaining to be settled by more careful investigation. It might be preferable to construct two parallel sewers, to be used and cleansed by flushing, or otherwise, alternately; or used for fecal matter, or for rain water alternately.

As to cleansing, it was objected that the velocity of 1¼ mile per hour would be insufficient, and a scouring power of 3 miles per hour was demanded by one authority, whilst another stated that a sewer constructed on a dead level, on account of the difficulty of obtaining outfall, was effectually flushed by having gates at intervals of 1600 feet. At Eton, the main sewer was stated to be horizontal, but having a good supply of water constantly running through it no deposit occurred. The quantity of water that could be brought to bear on the Lambeth main-sewer being unlimited, and used at each tide, it was argued that the velocity of 1¼ mile per hour would suffice to keep it clear.

The plan of the double reservoirs for the discharge of the sewage into the Thames would obviate any objections. One reservoir would be filled at low water, to that level, from the river, ready to receive the sewage; the other would be filled with the sewage, to a height of 2 feet to 6 feet above that level; into this latter, as the tide rose, the water would be admitted, the gates at the upper end being closed; at the turn of the tide, the lower gates being opened, the contents of the reservoir would be permitted to flow freely out, carrying away the whole of the sewage matter accumulated during the past 12½ hours, and commencing its exit at the turn of the top of the tide, the matter would never return to within half-a-mile of the spot whence it started. The capacity of the reservoirs being regulated accordingly, there would be no objection to discharging at low water in cases of heavy rain, as then both reservoirs would be used simultaneously for receiving the well-diluted sewage.

Even admitting certain valid objections to a flushing system, it was agreed to be more simple and quite as effectual as the pumping system, whilst it was decidedly more economical and less liable to derangement.

Allusion was made to the present comparative levels of the River Thames and the Lambeth district, and it was suggested whether the bed of the Thames, like that of the Mississippi, the Po, the Arno, and other streams, had not been artificially raised by alluvial deposit; and if so, whether a certain extent of embanking of the shores, so as to restrict the channel, without too much reducing the area for flood waters, would not deepen the centre, and afford a better outfall for the sewers at any given point.

Instances of the employment of the liquid sewage for agricultural purposes were mentioned, and it was urged that the introduction of water supply for habitations should always be followed by utilising the sewage from them, and that thus a valuable interchange might be established. To this it was replied that the comparative value of the rental of agricultural land and of that of the same area covered with buildings would show, that no parallel existed between the water supply to houses and that of pumping liquid manure for agricultural purposes, and that the schemes for that purpose were, with few exceptions, fallacious.

As to the general question of the drainage of London, it was argued, that with a good system of intercepting sewers, the gravitation plan could be adopted for the upper districts on both sides of the river, and on the north side, the whole sewage might be so disposed of; but on the south side, on account of the deficiency of fall, it would probably be necessary to resort to a system of pumping the low sewage, at some point, say at Deptford Creek, and there lifting it to such a height as to give the requisite fall from thence, by a sewer, into reservoirs, as proposed by Mr. Harrison, whence the matter should be delivered into the river, without any deodorising, at a point low down at the first turn of the tide from high water, so as to preclude the possibility of any pollution of the stream above the point of the admission of the sewage. It was contended, that the same skill by which steam power was enabled to be continuously used for long sea voyages, could preclude any but very remote chance of casualty from a derangement of the pumping apparatus, and that in the cases of excessive rainfall, flooding might be prevented by permitting the present outfalls into the river to be used.

As to the general question of deodorising, it was argued, that like the employment of the diluted sewage for agricultural purposes, the schemes might be feasible for small towns, but that the immense quantity proceeding from such an area of houses as in London, appeared at present to preclude the general adoption of the system.

Up to the present time, it appeared that all the plans proposed for the drainage of the southern district were defective in providing capacity of main sewers for conveying away the excessive rainfall, the amount of which was quoted to the meeting from returns supplied from the Royal Observatory at Greenwich.

It was shown, that at present, when a heavy rainfall occurred simultaneously with a high tide, the districts by the York-road and along the river side down to Bermondsey and lower down, were flooded from the river which flowed over the surface and down the gullies into the rivers, whence it flooded the houses. Therefore a greater pumping power would be required than had been mentioned, if the habitations were to be guaranteed from casualty, as they should be under a new and expensive system. It was contended, that the outfall should be extended even below Greenwich, as any system of sewerage for the southern districts should be permanent, and allow for any amount of extension of buildings to the eastward.

It was hoped that the facts elicited by the discussion would be found serviceable in determining the ultimate system to be adopted, and that special care would be taken to avoid the fallacies, which it was contended had been promulgated in some of the documents emanating, "by authority," from the General Board of Health; particularly in the "Minutes of information, collected with reference to works for the removal of soil water, or drainage of dwelling-houses, public edifices, etc." (1852.) Numerous errors, both of theory and practice, contained in those documents, were pointed out; and it was contended, that they set at nought all the received laws of hydraulics, the formulæ of De Buat and other experimenters of acknowledged scientific skill, and even the "Principia" of Newton, and only substituted fallacies for those rules which had hitherto formed the basis of the best practice. The tendency of such publications was contended to be very mischievous, and it was incumbent on practical engineers to furnish an antidote, by a careful examination of the published statements and an exposition of the errors; this was undertaken to be done, and was promised to be laid before an early meeting of the Institution.

Specimens were exhibited of Mr. Austin's *perforated bricks and blocks*, with dovetailed joints, for straight work and for circular or oval culverts; their merit was stated to consist in imparting great strength and solidity to the work, with the parallel joints, using less mortar, or cement, and enabling great speed to be employed in laying the blocks. The larger perforations were stated to be intended for ventilation, for channels for warmed air, or for passing holding-down bolts where the bricks were used instead of stone, for masses to resist impact or strain.

A simple and effective trough, with a cover, for containing the underground wires of the electric telegraph, was also on the table, and in the ante-room there were several ingenious sewer-grate traps, and other accessories for sewerage works, the invention of Mr. Austin and of Mr. Jennings.

*Jan.* 24.—On the reading of the abstract of the proceedings of the last meeting, regret was expressed that any remarks on the experiments published in the "Blue Books" emanating from the Board of Health, should have, apparently, been considered to have a personal application; nothing could have been more opposed to the intentions of the speakers, and they were convinced that if the authors of the "Blue Books" had consulted the engineer alluded to, the necessity for making the remarks would not have existed. This view was confirmed by the published results of an experiment, on a large scale, made under the direction of an engineer of the Board, so recently as December 16th 1853, at Alnwick. The line of earthenware pipe was 770 yards long, 18 inches diameter, and lying at an inclination of 1 in 400, with a square culvert 20 × 20 inches leading from a flushing chamber and stop-gate adjoining the weir from the river. In the first experiment the sluice was only sufficiently elevated to fill the pipe, when the results were:—

Velocity 3·581 feet per second, or 2·441 miles per hour.

Discharge 2367·78 gallons per minute, or 3,409,603 gallons per day of 24 hours.

Depth at delivery end 12½ inches.

In the second experiment the sluice was entirely taken out, causing the water to accumulate to a depth of 13 inches above the top of the pipe; when the results were:—

Velocity 3·915 feet per second, or 2·67 miles per hour.

Discharge 2588·04 gallons per minute, or 3,726,777 gallons per day of 24 hours.

Depth at delivery end 15 inches.

The second experiment gave the most decided results; the water being 13 inches above the top of the upper end of the pipe, and 3 inches below at the lower end; allowing for the hydraulic height due to the velocity, a working inclination was given of about 1 in 340; and assuming, in accordance with the received rules, the resistance to be as the square of the velocity, and, as a corollary, *cæteris paribus*, the velocity in pipes being as the square root of the mean hydraulic height —*i. e.*, as the square root of the diameter of circular pipes,—the velocity stated being about 235 feet per minute, and the real inclination being about 1 in 340, would, with these data, give for a pipe 6 inches diameter, at an inclination of 1 in 100, a velocity of 255 feet per minute.

According to the "Blue Books," the velocity stated from the original experiments of the Board of Health, at an inclination of 1 in 100, would be 325 feet per minute. The results of this experiment, in fact, coincided much nearer with those given by the formula, even as stated in the "Blue Book," than with the results of the pretended experiments therein.

For a similar pipe, with an inclination of 1 in 800, the velocity would be 88 feet per minute instead of 240 feet per minute, the formula giving a velocity of 75 feet per minute.

It was therefore contended, that whilst the recent experiments at Alnwick confirmed the accuracy of the results of the formula, they as clearly demonstrated the inaccuracy of the experiments and the erroneous deductions stated in the "Blue Book," which could not therefore be recieved as authority.

The Paper read was a *"Description of an improved Inclined Plane for conveying Boats to and from different Levels of a Canal."* By J. Leslie, M. Inst. C.E.

After alluding to the successful inclined plane, established by the author, at Blackhill, near Glasgow, on the Monkland Canal,* and describing the difficulties to be overcome, and the points essential for the good-working of such lifts, the paper proceeded to propound, as the simplest modification, in cases where there was a scarcity of water, and where vessels would bear being taken out of the water, to have two uniform inclined planes, descending each way, from a culminating point or summit placed at a suitable elevation above the water in the upper reach. Each of the inclines was cut down, for a distance from the

* See *Journal*, Vol. XV. 1852, p. 201, 270.

summit equal to the length of a carriage, fit to carry the largest boat, and a railway laid on a lower level in a segment of a circle vertically; the segment being traced from a centre so placed, that lines parallel to and equidistant from the inclined planes, should each be a tangent to the circle at a point half-way between their summit or apex, if produced, and the terminations of the segmental rails.

On this curved railway there was a lower or subsidiary carriage, running on a number of rollers; so as to have no friciton on the axles, and having straight rails and ratchets on its upper surface. When the lower carriage was at either end of the curved railway, its upper surface formed a direct continuation of one of the inclined planes; and being exactly one half of the length of the curved railway, the uppermost point of the rails fixed on the carriage coincided exactly with the apex of the two inclines.

The principal carriage with a boat on it was then run forward so as to stand on the lower carriage, by a rope attached to a drum on the shaft of the fixed engine, and was held in its place by palls dropping into the ratchets, when the lower carriage, with the travelling carriage and the boat on it, was moved forward by a wheel working in a rack under the lower carriage, which was thus made to traverse the apex or summit, and descended until the surface of the rails in the lower carriage and on the incline became identical, and the upper carriage was lowered into the water by the rope motion and the boat was allowed to float from it into the next reach of the canal.

This plan was first proposed for removing vessels from a small dock by the side of the Vistula, at Warsaw, so as to be out of the reach of floods and of ice, and whenever there was a scarcity of water for lockage, or for working caisson inclined planes, it was admitted to be a desirable modification.

In the discussion, after paying a just tribute to the ingenuity and skill of the author, it was admitted, that inclines of this nature were only applicable for certain exceptional situations; that in general it would be cheaper to pump up the water for lockage, using over again as it might be required, and that in general the competition between railways and canals had ended in the partial abandoning of the latter, in spite of all attempts to use steam propulsion and traction.

## NEW PATENTS.

### PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAW AMENDMENT ACT.

*Dated August 13.*

1900. J Gwynne, Essex Wharf, Essex-street, Strand—Improvements in the preparation of a black powder from coal, and the application thereof to the manufacture of paints, blacking, and various other purposes.

*Dated August 29.*

2004. J. H. Johnson, Lincoln's-inn-fields—Improvements in the preparation and application of gluten. (A communication from F. Durand, Toulouse, France.)

*Dated October 18.*

2404. E. Rider, Coleman-street—Improvements in the manufacture or treatment of gutta-percha; being improvements upon the invention secured to him by letters patent dated the 20th July, 1852. (Partly a communication.)

*Dated October 25.*

2456. C. R. N. Palmer, Amwell, Hertford—Improved mode and apparatus for preventing accidents on railways (including improvements in signalising apparatus.)
2462. A. V. Newton, Chancery-lane—Improved construction of railroad carriage axle. (A communication.)

*Dated November 5.*

2576. J. Barlow and T. Settle, Bolton-le-Moors, Lancashire—Improvements in power-looms for weaving.

*Dated November 17.*

2667. W. Hunderwood, Handsworth, Staffordshire—Improvements in cooking-stoves.

*Dated November 21.*

2701. A. Parfitt, Newbury, Berks—Improvements in the construction of certain descriptions of vehicles.

*Dated November 22.*

2712. R. Adams, King William-street—Improvements in fire-arms.

*Dated November 25.*

2741. A. A. V. S. de Montferrier, Paris—Improvements in wheels for vehicles on common roads and railways.

*Dated November 28.*

2771. J. C. Ramsden, Bradford. York—Improvements in apparatus or the mechanism of looms for weaving a certain class of plaids, checks, and fancy woven fabrics.

*Dated November 29.*

2776. E. J. Hughes, Manchester—An improved method of purifying and concentrating the colouring matter of madder, munjeet, spent madder, or any preparations thereof, however they may be made.

*Dated December 1.*

2793. T. Garnett, Low-moor, near Clitheroe, and D. Adamson, Duckinfield—Improvements in generating steam and in consuming smoke.
2794. A. E. L. Bellford, Castle-street—Improvements in machinery for manufacturing horse-shoes. (A communication.)
2795. A. I. Jones, New Oxford-street—Improved cigar-light.
2796. J. Dilworth, Preston—Improvements in escape-valves and safety-valves.
2797. T. Hollinsworth and J. Hollinsworth, Winwick, near Warrington—Improvements applicable to alarm-whistles, to be used upon railways, or as signals where otherwise required.
2798. J. H. Johnson, Lincoln's-inn-fields—Improvements in the treatment or manufacture of caoutchouc. (A communication.)
2799. J. H. Johnson, Lincoln's-inn-fields—Certain applications of vulcanised india-rubber. (A communication.)

*Dated December 2.*

2800. J. Reilly, Manchester—Improvements in machinery or apparatus for tenoning mortising, and sawing wood, metal, or other materials.
2801. A. W. Callen, Peckham—Improved excavating and dredging machine. (A communication.)
2802. A. E. L. Bellford, Castle-street—Improvements in blocks for ships and other uses. (A communication.)
2803. H. Deacon, Widnes, and E. Leyland, St. Helen's—Improvements in apparatus for the manufacture or production of sulphuric acid.
2804. A. Brown, Glasgow—Improvements in metallic casks and other vessels.
2805. G. Williamson, Glasgow—Improvements in applying motive power.
2806. A. Bain, Paddington—An apparatus for damping paper and other substances, in order to prepare the same for the reception of labels, stamps, and other like articles coated with a gummy or adhesive matter.
2807. J. C. Wilson, Redford Flax Factory, Thornton, Kirkcaldy, N. B—Improvements in machinery for scutching flax, hemp, and other fibrous materials.
2808. G. Collier, Halifax—Improvements in looms for weaving.
2809. R. Reyburn, Greenock—Improvements in sugar refining.
2810. S. C. Lister, Bradford, Yorkshire—Improvements in combing wool, hair, cotton, and other fibrous materials.
2811. H. Bessemer, Baxter House, Old St. Pancras-road—Improvements in the manufacture and refining of sugar.
2812. J. Saunders, St. John's-wood—Improvements in the manufacture of rails for railways.

*Dated December 3.*

2813. C. E. Green, Blandford-street, Portman-square, and J. Bayliss, Parliament-street—Improvements in machinery to save persons and property in case of fire; which machinery may also be applied for the purpose of raising and lowering weights of any kind; also for the purpose of compression, and for other useful purposes.
2814. A. Rogers, Bradford, Yorkshire—Improvements in ventilating sewers, mines, or other subterranean works.
2815. C. Buck, Wellington—Improved apparatus for retarding or stopping the progress of wheel carriages.
2816. W. Dray, Swan-lane—Improvements in the construction of portable houses and buildings.
2817. J. Gwynne and J. E. A. Gwynne, Essex Wharf, Strand—Improvements in the manufacture of fuel; its preparation and applications for the reduction of ores, fusing and refining metals, cementation or making steel, and treating salts. (A communication.)
2818. H. J. Iliffe and J. Newman, Birmingham—Improvements in the construction of metallic bridges and other similar structures.

*Dated December 5.*

2820. S. Cheavin, Spalding—Double-action or belt filterer.
2821. B. Skillman, Crosby-hall Chambers—Improved mode of preparing sheets of paper suitable for postal communication.
2822. W. Simons, Glasgow—Improvements in propelling and steering vessels.
2823. M. A. Muir, Glasgow—Improvements in check and fancy weaving.
2824. J. Patterson, Beverley—Improvements in reaping-machines.
2825. T. Storey, Phœnix Foundry, Lancaster—Improvements in the construction and arrangement of apparatus employed in connection with sewers.
2826. J. Robertson, Kentish Town—Improvements in the consumption or prevention of smoke.

*Dated December 6.*

2828. E. Oldfield, Salford—Improvements in machinery for spinning and doubling.
2829. J. C. Haddan, Chelsea—Improvements in the manufacture of cartridges, and of wads or wadding for fire-arms.
2831. A. E. L. Bellford, Castle-street—The manufacture of an artificial tartaric acid, and the application of the same to useful purposes. (A communication.)
2832. G. Ross and J. Inglis, Arbroath—Improvements in looms.
2833. T. Mills, Leicester—Improvement in the manufacture of lined gloves.
2834. W. E. Gaine, Harewood-street—Improvement in treating or preparing paper.
2835. R. C. Witty, Portland-place, Wandsworth—Improvements in the construction of boiler and other furnaces.
2836. J. H. Johnson, Lincoln's-inn-fields—Improvements in printing oil-cloths and other fabrics. (A communication.)
2837. J. Bernard, Regent-street—Improvements in machinery or apparatus for stitching or uniting and ornamenting various materials.
2838. J. Hargrave, Kirkstall, Yorkshire—Improved apparatus for washing and scouring wool.
2839 A. V. Newton, Chancery-lane—Improvements in fire-arms and ordnance. (A communication.)

*Dated December 7.*

2840. W. Slater and R. Halliwell, Bolton-le-Moors—Improvements in machinery for spinning.
2841. L. H. Bates, Bradford, Yorkshire—Improvements in machinery for stamping and cutting metal nuts and other similar metal articles.
2843. J. Getty, Liverpool—Improvements applicable to the plating of iron ships; part of which improvements is also applicable to the construction of boilers.

*Dated December 8.*

2844. W. G. Reeve, Elizabeth-street, Eaton-square—An appendage to horseshoes, to supersede the necessity of roughing them, as hitherto practised.
2845. W. B. Adams, Adam-street, Adelphi—Improvements in railway wheels, their axles and boxes.
2846. W. T. Henley, St. John-street-road—Improvements in electric telegraphs.
2847. T. Morau, Dublin—Improved means or apparatus for the prevention of accidents on railways in certain cases.
2848. B. Solomons, Albemarle-street, Piccadilly — Improvements in telescopes and other glasses in their application to the measurement of distance.
2849. W. C. Jay, Regent-street—An improved cloak.
2850. J. Goddard and C. Yates, Tottenham-court-road—Improvements in machinery or apparatus for obtaining and applying motive power.
2851. J. Robinson, Denton Mill, Carlisle—Improvements in mills for grinding corn and other substances.
2852. J. Nelson and D. Boyle, Selby—Improvements in scutching flax and hemp.
2853. J. Beall, Cheshunt—Improvements in apparatus for applying sand to the rails of railways.
2854. W. E. Newton, Chancery-lane—Improved machinery for drilling or boring rocks and other hard substances. (A communication.)
2855. P. J. T. Bordone, Paris—Improvements in extracting and treating the juice of beetroot and other vegetables.
2856. M. G. Lavertet, Paris—Improved mode of treating photographic pictures.
2857. R. Murgatroyd, Bradford, Yorkshire—Improvements in washing or scouring wool and fabrics composed entirely or partly of that material.

*Dated December 9.*

2858. J. B. E. Ruttre, Paris—Improvements in machines for producing shoddy from woven fabrics, and for sorting the fibres of fibrous materials.
2859. P. M. Fouque, L. R. Hébert, and V. E. D. le Marneur, Paris—Improvements in rudders.
2860. A. James, Redditch — Improvements in counting, measuring, and weighing needles, and in preparing papers to receive the same.
2861. D. Christie and J. Cullen, Bromley—An atmospheric counterbalance slide-valve for the steam-engine, hydraulic, and all other machines in which the slide-valve is used or required.
2862. A. Shanks, Robert-street, Adelphi—Improvements in instruments and apparatus for indicating or measuring weights and pressures.

2863. C. Mackenzie, Bayswater, and A. Turnbull, Manchester-square—Machinery for paring fruit and vegetables.
2864. J. Winspear, Liverpool—Improved mode of coating metals, wood, stone, and plaster, to preserve them from decay.
2865. R. Eccles, Wigan, and J. Mason and L. Kabery, Rochdale—Improvements in slubbing and roving frames for cotton and other fibrous substances.
2866. J. Sutcliffe, Manchester—Improvements in steam-engines, and in apparatus connected therewith.
2867. F. Osbourn, Aldersgate-street—Improvements applicable to the distribution of manure.
2868. J. Chisholm, Holloway—Improvements in the distillation of organic substances, and in obtaining products therefrom.
2869. J. H. Johnson, Lincoln's-inn-fields—Improvements in portable cases for containing provisions. (A communication.)
2870. G. Morley, Birmingham—Ornamenting or producing pictures on japanned goods, panels, canvas, or other material, whereby a vast amount of artistic skill and labour is superseded.
2871. W. Schaeffer, Stanhope-terrace—Improvements in purifying spirit.
2872. J. Bourne, Port Glasgow—Improvements in steam-engines.
2873. J. Bourne, Port Glasgow—Improvements in machinery for the production of iron ships and other similar structures.
2874. J. Bourne, Port Glasgow—Improvements in the construction of iron ships.
2875. H. Bessemer, Baxter House, Old St. Pancras-road—Improvements in the construction of railway axles and breaks.

*Dated December* 10

2876. A. Macpherson, Brussels—Improvements in disinfecting sewers or other drains or depositories of fetid matters or gases, and in converting the contents thereof to useful purposes.
2877. W. Muir, Brittannia Works, Manchester—Improvements in machinery and apparatus for cutting out parts of garments.
2878. C. Coates, Sunnyside—Improvements in and applicable to looms for weaving.
2879. H. L. Du Bost, Rue Neuve des Petits Champs, Paris—Improvements in the construction of locks and keys.
2881. J. H. Johnson, Lincoln's-inn-fields—Improvements in furnaces for the manufacture of steel. (A communication.)
2882. E. Green, Wakefield—Improvements in boilers and furnaces.
2883. N. V. Guibert, Paris—Improvements in forge-hammers.
2884. W. Thornley, Clayton West, Yorkshire—Improved manufacture of woven fabrics.

*Dated December* 12.

2885. E. O. W. Whitehouse, Brighton—Improvements in effecting telegraphic communications.
2886. T. Hollinsworth, Winwick, near Warrington—Improvements in the method of applying breaks to carriages employed upon railways, and in the machinery or apparatus connected therewith.
2887. W. Evans. Myrtle-street, Hoxton—Improvements in obtaining and applying motive power.

*Dated December* 13.

2888. W. Redgrave, Croxley-green, Rickmansworth—Improved safety travelling-cap.
2889. G. K. Hannay, Ulverston—The combination and manufacture of composition grinding-wheels, hones, and other grinding bodies.
2890. J. Wansbrough, the Grove, Southwark—Improvements in the manufacture of waterproof fabrics.
2891. W. F. Plummer, St. Mary's Overy Wharf, Southwark—Improved machinery for grinding or crushing animal, vegetable, and mineral substances.
2892. C. Schiele, Oldham—Improvements in preventing undue oscillation in engines, machinery, carriages, and other apparatus.
2893. A. G. Gueedron, Montmartre—Improvement in or addition to sugar-basins.
2894. A. G. Gueedron, Montmartre—Method of producing plans in relievo.

*Dated December* 14.

2895. P. Grant, Manchester—Improvements in printing-presses.
2896. F. A. Gatty and E. Kopp, Accrington—Improvements in printing and dyeing cotton, wool, silk, and other fibrous substances.
2897. J. A. Coffey, Providence-row, Finsbury—Improved method of evaporating liquids.
2898. E. Beanes, Charlotte-street, Portland-place—Improvements in the manufacture and refining of sugar.
2899. J. Z. Kay, Dundee—Improvements in gas-meters.
2900. B. Fullwood, Abbey-street, Bermondsey—Improvements in the manufactuure of cement.
2901. J. Wibberley, Eagley, near Bolton—Improvements in machinery or apparatus for winding yarns or threads on to spools or bobbins.
2902. R. J. N. King, Exeter—Improved artificial bait for fish.
2903. R. Parrock, Glasgow—Improvements in coats and similar articles of dress.
2904. W. B. Johnson, Manchester—Improvements in machinery or apparatus for making bricks and other articles from clay and other plastic materials.

*Dated December* 15.

2905. E. H. Rascol, Catherine-street, Strand—Improvements in retorts for the manufacture of gas. (A communication.)
2906. S. Messenger, Birmingham—Improvement or improvements in railway, ship, and carriage lamps.
2907. T. Pugh and W. Kennard, King-street, Snow-hill—Improvements in locks and latch-spindles.
2908. J. B. Howell and J. Shortridge, Sheffield—Improvement or improvements in the helves of tilt-hammers.
2909. J. P. H. Vivien, Paris—Improvements in the manufacture of paper and pasteboard.
2910. A. E. L. Bellford, Castle-street, Holborn—Improvement in blasting powder, for mining, and other operations of a similar nature. (A communication.)
2912. J. B. Pascal, Lyons—Improvements in obtaining motive power.
2913. F. W. Branston, Oak-tree House, Clapham—Improvements in certain tablets, labels, and signs, or their surfaces exhibiting letters and designs.
2914. C. J. Morris, Kirby-street, Hatton-garden—Improvements in bookbinding.
2915. B. Whitaker, Brighton—Improvements in the manufacture or production of useful toys.
2916. A. Cochran, Kirkton Bleach Works, Renfrew—Improvements in the application of starch or other substances of a similar nature to woven fabrics, and in the machinery or apparatus employed therein.
2917. F. D. Gibory, Paris—Improvements in instruments for ascertaining heights and distances, and for levelling.
2918. A. B. S. Redford, Albion-place, Walworth-road, and Thomas Cloake, Saville-row, Walworth-road—Improvements in retarding and stopping the progress of railway carriages.

*Dated December* 16.

2919. W. Binnion, Birmingham—Improvements in carriage and other lamps.
2920. W. G. Whitehead, Birmingham—Improvement or improvements in hats, caps, bonnets, and other coverings for the head.
2921. W. Tranter, Birmingham—Improvements in fire-arms, and in bullets and waddings to be used therewith.
2922. A. Limousin, Paris—Improvements in looms for weaving pile fabrics, and in a mode and apparatus for cutting the pile.
2923. A. Médail, Paris—Improved hydraulic machine.
2924. T. Williams, South Castle-street, Liverpool—Improved revolving pistol.
2925. T. S. Truss, Cannon-street—Improvements in breaks for railway carriages and other vehicles.
2926. T. S. Truss, Cannon-street—Improvements in apparatus for communicating between the engine-driver and the guard of railway trains.
2927. J. H. Johnson, Lincoln's-inn-fields—Improvements in dyeing. (A communication from M. Bellancourt, Rheims.)
2928. J. H. Johnson, Lincoln's-inn-fields—Improvements in the treatment or preparation of wool, and of the wash-waters employed in such treatment. (A communication from Messrs. Villermet and Manheimer, Paris.)
2929. S. Norris, New Peter-street, Horseferry-road—Improvements in lighting and extinguishing gas-lamps.
2930. S. Smith, Horton Dye Works, Bradford—Improvements in preparing rovings and yarns of wool.
2931. A. Parkes, Birmingham—Improvements in separating silver from its ores or other compounds.
2932. R. B. Hall, Whitecross-street—Improvements in crushing and grinding quartz, minerals, and other matters.
2934. A. L. Knox, Glasgow—Improvements in ornamenting certain descriptions of textile fabrics.
2935. J. Thompson, Clitheroe—Improvements in machinery or apparatus for stretching textile fabrics as they are wound into laps or rolls. after the processes of bleaching and dyeing, or operations connected therewith.
2936. R. W. Walthman, Bentham House, York—Improvements in belts or bands for driving machinery for use in mines, and for other purposes.

*Dated December* 17.

2937. J. S. Bailey, Keighley, York—Improvements in machinery for operating upon wool, alpaca, mohair, and other fibrous materials, preparatory and prior to being spun.
2938. J. Horton, Birmingham—Improvements in the manufacture of certain kinds of metallic vessels.
2939. G. Anderson, Gas Works, Rotherhithe—Improvements in apparatus used when manufacturing gas, which apparatus or part of which is also applicable when transmitting gas from one place to another.
2940. C. Bedells, Leicester—Improvements in the manufacture of elastic fabrics.
2941. J. D. M. Stirling, Larches, near Birmingham—Improvements in the manufacture of iron.
2942. J. Greenwood, Arthur-street West, London-bridge—Improvements in preventing draughts of air into rooms and places when the doors and windows are shut.
2943. I. James, Cheltenham—Improvements in carts for distributing water or liquid manure.
2944. M. P. Houghton and A. Stewart, Hillmorton—Improved means of preventing accidents on railways.
2946. R. Whewell, Little Bolton, Lancaster—Improvements in machines used for cutting paper.

*Dated December* 19.

2947. H. Milward, Redditch—New or improved machinery for manufacturing needles and fish-hooks. (A communication.)
2948. J. Tribelhorn, St. Gall, and P. Bolley, Aarau, Switzerland—Improvements in the process of bleaching vegetable fibrous substances. (A communication from C. Custer, Alstaetten, Switzerland.)
2949. A. E. L. Bellford, Castle-street, Holborn—Improvements in paddle-wheels for propelling vessels. (A communication.)
2950. W. Crossby, Devonshire-street, Sheffield—The ventilation of granaries, store-houses, or places of deposit for grain whatsoever, and for improvements in the grinding of grain and dressing of grist, and grinding generally.
2951. A. E. L. Bellford, Castle-street, Holborn—Improvements in presses for expressing oil or other fluids from fruits, grains, or other substances. (A communication.)
2952. R. Waygood, Newington-causeway—Improvements in portable forges.
2953. D. Goldthorp, Cleckheaton, near Leeds—Improved propeller.

*Dated December* 20.

2954. A. Paterson, Westminster—Improved cooking apparatus.
2955. J. H. Campbell, King's Arm's-yard, Coleman-street—Improvement in machinery for cutting corks.
2956. J. L. Clark, Chester-villas, Islington—Improvement in insulating wire used for electric telegraphs, with a view to obviate the effects of return or inductive currents.
2957. H. E. F. de Gergy Veuve Durut, Paris—Improvements in the manufacture of bread.
2958. P. Wagenmann, Bonn, Rhenish Prussia—Improvements in the manufacture of liquid hydro-carbons and paraffine.
2959. J. Boydell, Gloucester-crescent—Improvements in the manufacture of wrought-iron frames.
2960. E. M. F. Lemaire, Rue Drouot, Paris—Improvements in tanning.
2961. J. Webster, Cornwall-road, Stamford-street—Improvements in acting on drying oils and preparing varnishes.
2962. J. Burrows, Haigh Foundry, near Wigan—Improvements in the formation of such metallic plates as are required to be conjoined by riveting or other similar fastening.
2963. J. Burrows, Haigh Foundry, near Wigan—Improvements in the construction of steam-boilers or generators, and in the arrangement of furnaces connected therewith.
2965. R. B. Huygens, Holland—Improvements in machinery for crushing, washing, and amalgamating gold and other ores and substances.

*Dated December* 21.

2966. G. Boccius, Hammersmith—Apparatus adapted to the breeding and rearing of fish.
2967. C. J. Farrington, Hampstead—Improvements in signalling and preventing collisions on railways by electrical communication.
2968. H. Kohnstamm, Union-court, Old Broad-street—Improvements in the manufacture of imitation leather.
2969. T. V. Lee, Lockyer-terrace Plymouth—Improvements in the construction of certain machinery and apparatus for the manufacture of bricks and tiles.
2970. J. Dining and W. Inglis, Southampton—Improved apparatus for purifying and filtering residuous water.
2972. J. Jones, Glasgow—Improvements in governors or regulators for steam-engines and other machinery.

*Dated December* 22.

2973. J. Youil, Burton-upon-Trent—Improvements in the mode or method of obtaining power to raise liquids, and of treating the said liquids when raised, and of using them to obtain additional power.
2974. L. A. F. Besnard, Paris—A new system of painting, by means of lithography, without leaving a particle of paper upon the canvas.
2975. P. A. L. de Fontainemorean, South-street, Finsbury—Improvements in constructing and applying connecting-rods. (A communication.)
2976. W. H. Woodhouse, Parliament-street, Westminster—Improvements in the construction of roads, ways, and ducts.
2977. C. Lewis, Hull—Improved lamp for signalling.
2978. B. Murgatroyd, Bradford, York—Improvements in washing or scouring wool, alpaca, and mohair, and fabrics composed entirely or partly of those materials.

2979. T. Berry, Rochdale, J. Mangnall, and J. Chadwick, Heywood—Improvements in winding and twisting wool, cotton, and other fibrous materials.
2980. J. Gibbons, jun., Wolverhampton—Improvements in locks and latches.
2981. J. Shaw, Hatton-garden—Improvements in pianofortes. (A communication.)

*Dated December 23.*

2982. J. Gillow, jun., Northwich, Chester—Improvements in the manufacture of salt.
2983. J. Britten, Birmingham—Improvements in girders, bridges, roofs, and other such like structures.
2984. J. O'Neil, Bury, Lancaster—Improvement in apparatus for drawing condensed steam and air from pipes or other chambers in which steam is used.
2985. F. Bennock, Wood-street, Cheapside—Improvements in coating silk and other yarn or thread with gold or other metal. (A communication.)
2986. J. D. Pfeiffer, Paris—Improvements in machinery or apparatus for cutting paper and similar material.

*Dated December 24.*

2987. R. G. Coles, Cheltenham—Improvements in the locks of fire-arms.
2988. J. Gaulter, Paris—Improved apparatus for washing and bleaching.
2989. G. Goutaret, Paris—A new system of propulsion.
2990. J. Margerison, Preston—Improvements in railway-breaks.
2991. H. Hardinge, New York—Manufacturing liquid quartz or silex, to be used in the manufacture of certain compositions for ornamental and useful purposes.
2992. G. A. Buchholz, Gould-square, Crutchedfriars—Improved machinery for the cleaning and hulling or dressing of rice, wheat, and other grain.
2993. J. Lewis, Salford—Improvements in apparatus for drilling or boring metals and other substances.
2994. T. Cooper, Leeds—An improvement applicable to the binding of ledgers and other books.

*Dated December 27.*

2995. T. W. Makin, Manchester—Improvements in machinery or apparatus for finishing woven fabrics.
2997. F. C. Calvert, Manchester—Improvements in the treatment of naphthas and other volatile hydro-carbons, and in the application of the same to various useful purposes. (A communication.)
2988. G. J. Mackelcan, Lechlade, Gloucester—Improvements in winnowing or corn-dressing machines.
2999. S. Sedgwick and T. Dawson, Piccadilly—Improvements in the moderator-lamp, or in lamps of a similar principle.
3000. T. S. Prideaux, St. John's-wood—Improvements in apparatus for regulating the supply of air to furnaces, and for preventing radiation of heat from fire-doors and other parts of the fronts of furnaces.
3001. T. Molyneaux, Manchester—Improvements in winding and doubling silks; a part of which improvement is applicable to the treatment of other fibrous substances.

*Dated December 28.*

3002. J. Parkinson, Bury, Lancaster—Improvements in governors for regulating the pressure of steam, gas, and other fluids or liquids.
3003. J. Moffat, Heiton, Scotland—Improvements in the means of communication between the guard and the engine-driver in a railway train.
3004. J. Taylor, Britannia Works, Birkenhead—Improvements in raising and lowering weights.
3005. W. U. Coates, Ombersley, Worcester—A new or improved rotary steam-engine.
3006. J. Alexis, Avignon, France—Improved railway-break.
3007. R. Green, Flint Glass Works, Brettell-lane, Stafford—Improvements in insulators for insulating the wires or rods employed for conducting or transmitting electricity.
3008. J. Macintosh, Pall-Mall East—Improvement in discharging projectiles.
3009. J. Barnes, Church, Lancaster—Improvement or improvements in dyeing and cleansing cotton, silk, wool, and other fabrics.
3010. Francis Parker, Northampton—Improvement in the manufacture of gaiters.
3012. D. M'Nee, Hillfield, Dumbarton, and A. Broadfoot, Ingram-street, Glasgow—Improvements in printing with colours on cloth; which are also applicable to printing ornamental designs on paper or other surfaces.
3013. T. Phillips, jun., Sparkbrook, and S. Phillips, Birmingham—Improvements in the construction of window-shutters; which improvements are also applicable as an additional security for doors and other similar openings.

*Dated December 29.*

3014. H. Jackson, High-street, Poplar—Improvements in machinery for moulding bricks and other articles of brick-earth.
3015. E. Estivant, Givet, France—Improvements in the manufacture of tubes of copper and its alloys.
3016. M. Phillips, Birmingham—Improvement or improvements in metallic revolving or winding shutters. (A communication from her late husband.)
3017. A. F. Rémond, Birmingham—New or improved metallic tubes.
3018. J. White, East-street, Red Lion-square—Improvements in friction-joints or fastenings.
3020. C. A. Roux, Belleville, near Paris—Improvements in printing warps of cut pile and similar fabrics.
3021. H. C. Vion, Paris—Improvements in pistons and stuffing-boxes of engines moved by water, steam, or gas.
3022. A. V. Newton, Chancery-lane—Improvements in the manufacture of screws. (A communication.)

*Dated December 30.*

3025. B. Swire, of Ashton-under-Lyne—Improvements in machinery or apparatus for making metal tips for shoes and clogs.
3026. H. C. C. de Ruolz and A. de Fontenay, Paris—An improved metallic alloy.
3027. J. Marlor, Oldham, Lancaster—Improvements in ascending and descending mines and shafts, and in the apparatus connected therewith, by which said improvements the ventilation of mines is increased.
3028. W. Mabon, Ardwick Iron Works, Manchester—Improvements in machines used for riveting together metallic plates.

*Dated December 31.*

3029. I. Holroyd, Sowerby-bridge, York—Improvements in apparatus employed in singeing textile fabrics.
3030. J. Milner, Stratford, Essex—Improvements in connecting the rails of railways.
3031. H. V. Physick, North-bank, Regent's-park—Improvements in electric telegraphs, and in apparatus connected therewith.
3033. J. Pym, Pimlico—Improvements in machinery for grinding auriferous and other ores, and separating the metal therefrom.
3034. W. Tuxford, Boston, Lincoln—Improvements in portable thrashing-machines; part of which improvements is also applicable to fixed thrashing-machines.
3035. A. Trueman, Swansea, and I. Baggs, London—Improvements in grinding, amalgamating, and washing quartz and other matters containing gold.
3036. R. Waygood, Newington-causeway—Improvements in portable forges.
3037. J. Holbrey, Bradford, York—Improved machinery for combing wool and other fibrous materials.
3038. J. Slater, Salford, Lancaster—Improvements in cocks, taps, or valves.
3040. T. Brown and P. Macgregor, Manchester—Improvements in power-looms for weaving.
3041. A. Oppenheimer, Manchester—Improvements in the manufacture of silk-velvet and other such piled goods or fabrics.
3042. B. Hunt, Brighton—Improvements in obtaining and applying motive power.
3043. P. Sonntag, Paris—Improved apparatus for measuring and fitting garments of persons.
3044. F. A. Clerville, Paris—Improvement in the construction of fire-arms.
3045. S. T. M. Sorel, Paris—Improved compositions to be employed as substitutes for caoutchouc, gutta-percha, and certain fatty bodies.

*Dated January 2, 1854.*

1. C. H. Collette, Lincoln's-inn-fields—Improvements in the manufacture of sugar. (A communication.)
2. E. D. Smith, Hertford-street, May-fair—A mode of communication between the passengers, guards, and engineer of a railway train.
3. A. Dawson, Barne's-place, Steyney—Converting small coal or coal-dust, or small coal and coke into solid blocks of fuel.
4. J. Gowans, Edinburgh—Improvements in apparatus for heating and ventilating, and in baths and washing apparatus connected therewith, applicable to dwelling-houses.
5. P. A. Montel, Paris—Improvements in stopping the trains on railways.
6. P. A. de Fontainemoreau, South-street, Finsbury—Improvements in dyeing wool. (A communication.)
7. P. A. L. de Fontainemoreau, South-street, Finsbury—Improvements in water-wheels. (A communication.)

*Dated January 3.*

8. H. L. Corlett, Summer-hill, Dublin—Improvements in caoutchouc springs for locomotive engines and tenders, railway carriages, and wagons.
9. J. Madeley, Walsall, Stafford—Improvement or improvements in the manufacture of certain kinds of tubes, and in nuts for the heads of screws.
10. D. Kennedy, Reading, U. S.—Invention for the use of tanners, being certain compositions of matter to be used in the manufacture of leather.
11. J. Strovold, Barnes, Surrey—Improvements in machinery or apparatus for sifting and washing gravel or other similar substances.
12. F. A. T. de Beauregard, Paris—Improvements in drying cigars and ligneous materials or other substances.
13. E. J. Wilson, Oxford-street—Improved method of making portfolios, music-books, brief-cases, and pocket-books.
14. J. Collins, St. Ann-street, Liverpool—Improvements in the manufacture of vinegar.
15. J. I. Grylls, Murton-street, Sunderland—Improvements in whelps for the barrels of capstans, windlasses, and other machinery.
16. T. Mann, Horsham, Sussex—Improved cinder-sifting shovel.
18. J. Dransfield and W. Robinson, Oldham, Lancaster—Improvements in carding-engines for carding cotton, wool, and other fibrous substances.

*Dated January 4.*

19. D. Hulett, High Holborn—Improvements in gas-regulators for regulating the supply of gas to the burner.
20. J. Taylor, M. Wrigley, and S. Greaves, Oldham, Lancaster—Improvements in carding-engines for carding cotton, wool, and other fibrous substances.

*Dated January 5.*

21. J. Liddiard, Deptford, Kent—Improvements in the construction of furnaces, with a view to the prevention of smoke.
22. E. Schishkar and F. C. Calvert, Manchester—Improvements in dyeing and printing textile fabrics and yarns.
23. B. White, Newcastle-upon-Tyne—Improvements in the manufacture of waterproof fabrics, and of waterproof bags and other like articles.
24. J. H. Johnson, Lincoln's-inn-fields—Improvements in ventilating carriages and buildings; part or parts of such improvements being applicable to the obtainment of motive power. (A communication from J. Chillcott and G. Palmer, Brooklyn, U. S.
25. W. Rigby, Glasgow—Improvements in steam-hammers and pile-driving machinery.
26. L. J. Pomme, Paris—Improvements in reducing the friction of axles and axletrees of carriages.
28. A. V. Newton, Chancery-lane—Improved machinery for crushing or grinding and washing and amalgamating quartz, rock, and other substances. (A communication.)

*Dated January 6.*

29. I. Pearse, Cawsand, Cornwall—Improvements in means for navigating ships or other vessels.
30. H. H. Edwards, Ludgate-hill—Improvements in treating peat and vegetable matters for the purpose of fuel, as well as in the extraction of other useful products therefrom. (Partly a communication.)
31. R. Tait, Glasgow—Improvements in the manufacture or production of ornamental fabrics.
32. J. Radcliffe, Stockport, Chester—Improvements in power-looms for weaving.
33. J. Healey, Bolton-le-Moors, Lancaster—Improvements in spinning-machines known as mules, and in machines of similar character. (A communication from A. Peynaud and E. Paynaud, Charleval, France.)
34. M Poole, Avenue-road, Regent's-park—Improvements in the manufacture of dextrine, glucose, and alcohol, and in employing the products of such manufacture. (A communication.)
35. J. D. M. Stirling, Larches, Birmingham—Improvements in the manufacture of iron.
36. A. V. Newton, Chancery-lane—Improvements in the construction of motive-power engines; part of which improvements is also applicable to the packing of pistons generally. (A communication.)

*Dated January 7.*

38. W. E. Newton, Chancery-lane—Improved machinery for dyeing, washing, and bleaching fabrics. (A communication.)
42. N. M. Caralli, Glasgow—Improvements in the manufacture or production of ornamental fabrics.
44. H. S. Edwards, Paris—Improvements in preparing textile fabrics or materials for the purpose of their better retaining colours applied to them. (A communication.)

*Dated January 9.*

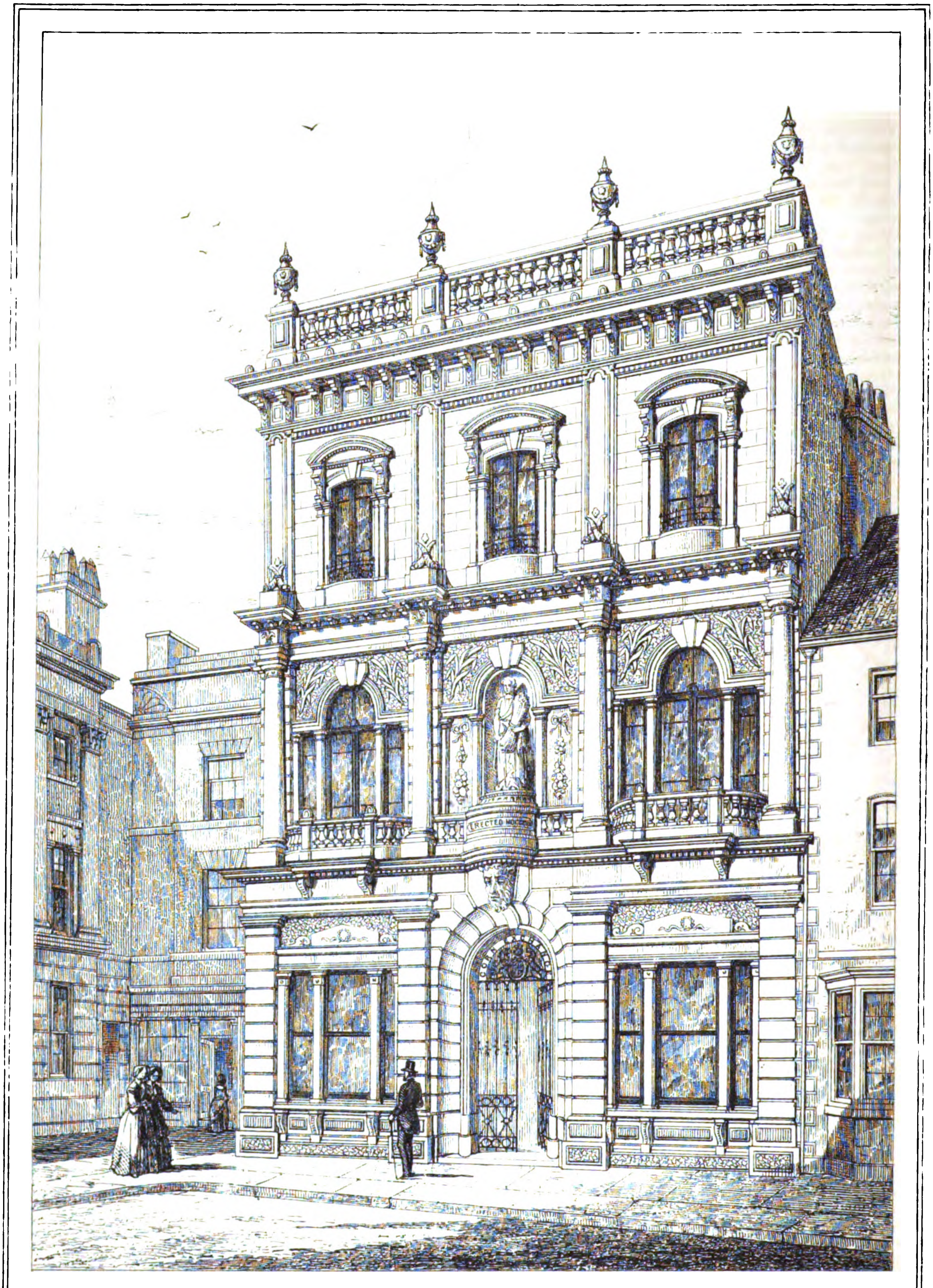
46. Z. Pettitt, Fordham, near Colchester—Improvements in thrashing-machines.
48. R. Husband, Manchester—Improvrments in the method of ventilating hats or other coverings for the head.
50. R. Howson, Manchester—Improvements in screw-propellers.

*Dated January 10.*

52. E. Tyer, Rhodes-terrace, Dalston—Improvements in giving signals on railways by electricity, and in instruments and apparatus connected therewith.
54. A. M. E. Boyer, E. Ducros, and O. Verdeau, Paris—Improved compounds to be used in dyeing.
56. Rev. W. R. Bowditch, Wakefield—Improvements in the purification of gas, and in the application of the materials to be employed therein.
58. A. Mitchell, Belfast—Improvements in propelling vessels.
60. A. Drevelle, Halifax—A new combing-machine, suitable for any textile or fibrous matter. (A communication from A. Morel, Roubaix, France.)

PATENT APPLIED FOR WITH COMPLETE SPECIFICATION.

3032. C. G. Schönheerr, Chemnitz, Saxony—Improvements in bobbin-machines. — Dec. 30.



J. R. Jobbins

PERSPECTIVE VIEW OF THE NEW CORN EXCHANGE, LOUTH.

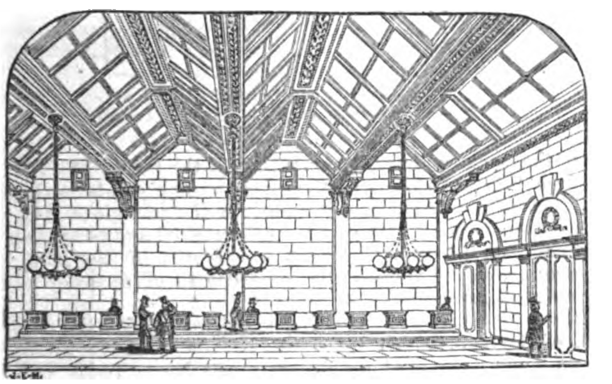
PEARSON BELLAMY, ARCHITECT.

## NEW CORN EXCHANGE, LOUTH.

(*With an Engraving, Plate* XI.)

It is only a few months since the project was conceived of erecting an Exchange in the important agricultural town of Louth, in Lincolnshire; and it is mainly by the exertions of a few spirited individuals that this object has been speedily accomplished. The capital for the purpose was raised in shares of 10*l.* each, the greater portion being held by the directors, of whom Charles North, Esq., an eminent agriculturist, residing at South Thoresby, near Louth, is the chairman, and Robert Norfolk, Esq., of Louth, one of the most influential merchants in the county, is vice-chairman.

The building is in this form, L, one front being 120 feet long, and the side-front 90 feet; total height, 60 feet. The façade a perspective view of which is given in Plate XI., is executed in Caen stone, of the modern Italian style of architecture, consisting of three stories, divided into three bays—the lower story by rusticated pilasters, the middle story by three-quarter Doric columns; in the centre compartment of this story over the arched entrance is a niche containing a figure of Ceres. The upper story is divided by deeply-panelled pilasters, surmounted by an enriched bold cantilever cornice, over which is a balustrade, with emblematical vases thereon. The basement story consists of extensive wine and porter vaults, and other requisite offices, occupied by Messrs. Lucas and Co. On each side of the principal entrance are offices for merchants, from which, rising by a broad flight of stone steps, the level of the Exchange-room is attained, which is entered from a spacious landing. The large room, shown in the annexed engraving, is 116 feet long, 37 feet wide, and 35 feet high. The whole area of the Exchange is covered with Hartley's patent rough plate glass, arranged in the ridge-and-furrow form, supported by enriched beams upon beautiful large carved corbels, modelled by Mr. T. W. Wallis, of Louth.



LARGE ROOM, LOUTH CORN EXCHANGE.

Over the front offices is a large dining-room, 35 feet by 24 feet, with bed-rooms in the attic story for the accommodation of the adjoining inn.

The most essential points (light, ventilation, &c.) appear to have been well considered—the former is extraordinarily good. The design throughout is chaste and original, and reflects credit on the designer, Mr. Pearson Bellamy, of the firm of Bellamy and Hardy, architects, Lincoln and Louth.

The amount of the contract for the building is 2510*l.*, including 400*l.* for the old Town-hall building, which originally stood on this site. The works have been executed by the contractor, Mr. John Levitt, of Louth, in a very efficient manner.

*New Streets.*—On the 15th inst. the new street from King William-street, London Bridge, to St. Paul's Churchyard (through Carter-lane, Doctor's Commons, Old Change, &c.) will be opened. Considerable progress has been made in the extension of Farringdon-street for the opening to Islington, and the new street is expected to be opened for traffic as far as Clerkenwell Green during the ensuing summer. On the Surrey side of the Thames, a new street, extending from the end of Stamford-street, Blackfriars-road, through the borough of Southwark to High-street, near the London Bridge railway terminus, is about to be constructed.

## ORDNANCE SURVEY OF SCOTLAND.

As the battle of the scales has not yet been fought out, so far as we are aware, the papers upon the subject not having been made public, an opportunity presents itself for examining somewhat in detail the much-contested but little understood subject of contour-levelling.

Contouring appears to be a life-and-death struggle with the Ordnance Survey authorities, as at present constituted. Should this mechanical system of obtaining the basis or groundwork for hill-shading the reduced maps be abandoned, they will be driven to the necessity of employing "men who can think and act and use discretion." What a fearful alternative, in an age when thought is beginning to develope itself to such an extent that even official dicta can no longer keep it confined under the rubbish of ignorance, the accumulation of bygone ages, and when the wise are directing the expanding thoughts, the rising genius of the age, into new and more profitable channels, and bringing the action of mind more directly into contact with the multifarious avocations of daily life.

Before entering fully into the subject, it may be as well to explain what is really meant by contour-levelling, and how the operation is performed.

A very clear and distinct idea may be formed by supposing a model of a district of country to be constructed to a natural scale (that is, having the horizontal and vertical scales equal), exhibiting all the undulations and irregularities of surface as they exist in nature. Suppose this model to be placed in a water-tight box, to the side of which let a scale be attached, standing vertically, and graduated to correspond with the scale at which the model has been constructed, and let the zero of the scale correspond to the horizontal base or datum plane upon which the model has been constructed.

Let water be now poured into the box until it reaches any given height upon the scale (say 25 feet), and draw a line around the model corresponding with the surface of the water. This line will be parallel to the datum plane upon which the model has been constructed, and will represent the first contour line. By the same process, any number of parallel lines may be drawn upon the model, and at any required vertical distance from each other.

The water being removed, the model will exhibit a number of lines or planes, all parallel to each other and to the datum plane of the model.

It will be observed, that if those lines are projected to the plane of the datum—which would necessarily be the case in order to represent the contour lines upon a plan—the horizontal distances between them would differ materially, according to the nature of the ground; the flatter the ground the greater the distance, and the steeper the ground the less the distance, would be between the contour lines upon the map.

It is essential that a series of levels, extending over a whole country, such, for example, as Ireland or Great Britain, should all proceed from one fixed point in each case, otherwise it is useless to expect anything but confusion, and the natural concomitant, "Revision."

As there is no fixed natural datum plane to which all levels can be referred, a single datum point should be adopted, and this point may conveniently be chosen as near as possible to the best natural datum plane. In the case of Ireland, for example, the low water, even if accurately ascertained at a great number of points round the coast, would not afford a natural datum from which a considerable number of starting or initial points could be adopted, and closing-in in the interior of the work, as these points would differ several feet from a true datum plane, and there would be no means of ascertaining the amount of this difference. This would also be the case if the high water at several points were used as starting-points; but the mean of high and low water, if accurately ascertained at several points round the coast, would be much nearer to a true datum plane than either the low or the high water. It would still however be extremely injudicious to make use of several initial points, even although based upon the most careful tidal observations, for the same series of levels, inasmuch as one extremely useful problem to be solved by these levels would be to ascertain accurately the relative height of high, of low, and of mean tides in all the harbours, estuaries, and numerous indentations round the whole coast. It would, in fact, be assuming as correct one important problem to be solved by the levels.

A reference to the "Report from the Select Committee on the Map of Ireland, 1853," will show how these important matters have been attended to.

Sir J. M'Neill, who is an uncompromising advocate of the Ordnance six-inch map, and of contouring, states, in answer to Question 78, that the figures would be all above the datum "*if there were one datum line established.*"

79. "Do not the figures indicate the altitudes of the different trigonometrical stations of observation?"—"Some are put in by levels, I believe; I believe the datum line is not uniform throughout."

Capt. Gossett was applied to in this dilemma, who does not much mend the matter; for, in answer to Question 80, he states, that "When the survey was in *its infancy*, the subject had not received the same experience which has since dictated uniformity throughout."

This answer suggests very important inquiries, which lie at the very root of the expenditure of vast sums of public money in the production of imperfect, or rather erroneous public documents. If the duration of this helpless, infantile state of things is to be estimated by the length of time during which the altitudes placed upon the engraved maps were derived from angular measurements, depending upon numerous ill-defined, low-water starting-points not in the same datum plane, we must conclude that the survey was in its infancy at least twelve or fifteen years after its commencement—about three-fourths of its entire existence, and was then only rescued from this helpless condition by Professor Airy.

81. "Is not the datum point for the altitudes which have been placed upon the six-inch map the same for every part of Ireland?"—"No, not precisely; we have *improved upon the map as years went by:* at first many of the altitudes were obtained only by vertical angles; we now make use of the levelling upon which Professor Airy's tidal calculations are founded. All our *revisions* of the map will be relative to one datum plane."

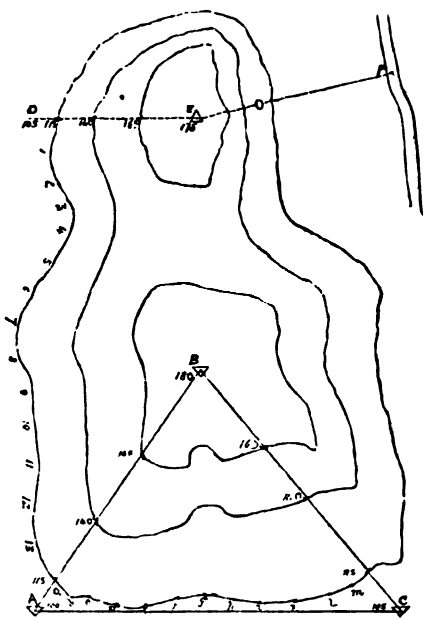
It is not quite clear from this answer whether the whole of the levels exhibited on the six-inch map of Ireland at the period of its completion in 1846, must be replaced by an entire new set of levels which shall refer to one datum plane, or whether there are some portions of the original maps with the levels referred to the new datum.

Ought there not be some effort made on the part of the government to fix the meaning of this mysterious term, "*Revision,*" as made use of by the Ordnance Survey authorities? It is doubtless frequently employed to mean an entire new survey, or an entire new set of levels, as the case may be.

Whatever claim to indulgence the Irish survey authorities may have with respect to a state of *infancy*, *childhood*, and *incipient manhood* in the production of a detailed survey for civil purposes, they can have no claim to the same indulgence in reference to the trigonometrical points and the levels with which they must have been familiar for forty or fifty years before the survey of Ireland commenced. These ought therefore to have been perfect from the commencement, and without calling in this much-abused term, "*Revision.*"

The accompanying engraving will sufficiently explain to our scientific readers the mode in which contour-levelling is performed. In order that the contour lines shall be surveyed and laid down upon a map with the same degree of accuracy with which the details of the map itself have been laid down, it is necessary that the principal lines of the triangles forming the trigonometrical basis of the survey shall be laid out and chained, to fix the several points where the contour lines cross the lines of the triangle. But as this would entail a second laying out and a second measurement of these lines, the detailed survey and the contouring should be combined (when the above accuracy is considered essential) into one and the same operation. In the triangle A B C, the altitude of the trigonometrical points A, and C, having been obtained from a system of accurate bench marks, derived from the initial starting or datum point, the lines A B, and C B, are laid out, chained, and levelled, and pickets driven into the ground at the points 115, 140, and 165, where these lines are crossed by the contour lines, and such other marks made as may be necessary for the survey of the detail to be shown on the map.

In commencing the contour-levelling at the point 115, on the line A B, the spirit-level is placed in the most convenient position to level along the line *a b c*, &c.; the staff is held upon the picket 115, which becomes the back station; the height is then read off and the staff is carried along the ground to the points *a*, *b*, &c., which give the same reading on the staff as the back station, and which points are consequently in the same datum plane. These points are marked by pickets or by marks cut into the ground so as to be easily discovered in subsequently surveying them. When as many points have been fixed as can conveniently be fixed from one position of the instrument, a forward station is selected, which will become the back station when the instrument has been carried forward to another position; and the same process will be carried on until the contour line is closed upon the point 115 on the line C B, and the accuracy of this close will be a test of the accuracy of the contour line from the point of starting.




In the same manner, commencing at the points 140, 165, on the line A B, and closing on the corresponding points on the line C B, the three contour lines included in the triangle A B C, will be completed; and if these lines are surveyed and plotted on an original plan in connection with the details of the map, the contour lines will possess the same degree of accuracy as the several matters exhibited on the map itself.

When, however, the contouring is carried on after the publication of the map, which is the case on the Ordnance Survey of Ireland, and when it would be too expensive to re-lay out the lines of the several triangles, the following process is adopted. From the bench-mark 105 at D, a line of levels is carried to the trigonometrical station E, and thence to the bench-mark F. These lines must be chained, in order that the levelled points may be plotted on the plan, and pickets are driven into the ground at 115, 140, and 165 on the line D E, and also at corresponding points of altitude on the line E F, when confidence can be placed in the party contouring, but if not, the check points are placed on the line E F, at some distance from the point at which the contour line would strike.

Commencing the contouring at the point 115 on the line D E, and proceeding along the line 1, 2, 3, 4, &c., as above described, and passing along the same line to the point O, on the line E F, as if the more accurate process described in reference to the triangle A B C, did not exist on the diagram. When the contour leveller has his check-points given him, he would ascertain on closing at the point O, if his work was correct; but if the check-points are retained, he must level to the point F, and send the height which he makes the point O above the point F, to the keeper of his conscience at a considerable distance, who informs him of the state of his work, which, if satisfactory, he may proceed to survey.

From this very brief and imperfect description, those who are acquainted with levelling will easily understand the process of contouring and the manner in which it is checked. In surveying the contour lines thus marked out upon the ground after the map has been completed, the survey is made to depend upon angles of fences, buildings, or any convenient object on the map. In mountain districts where there are no details upon which to base the survey, traversing must be resorted to.

It must be obvious that to contour accurately through dense woods, over steep precipices, through demesnes and pleasure grounds with high walls and other obstructions, is all but impracticable; and to attempt contouring in a town where the levels can only be placed upon the streets and the intermediate portions sketched, is a pure absurdity and calculated to mislead.

To attempt to get at the exact cost of contouring as executed by the Ordnance, is in reality to search for knowledge under difficulties. In the Report of the Committee on the Ordnance Survey (Scotland), pages 230-231, Capt. Yolland distinguishes between what he calls "Instrumental Contours" which "would be run at 25, 50, 75, 100, 150, 200, 250, 300, 350, 400, 500, 600, 800, 1000, 1200, 1600 feet (in altitude), and increases by 400 above that limit;" and below 1200 feet, the contours at every intermediate 25 feet not shown by the instrumental lines are what are termed "Sketch Contours," run with a water-level in lieu of a spirit-level.

It is difficult to account for the circumstance of so very imperfect an instrument as a "*water-level*" being employed by the Ordnance in the execution of a national survey. One of the great boasts of the Ordnance over Civil Surveyors, has been the possession of superior instruments, but this superiority can no longer be claimed after the adoption of a miserable make-shift instrument such as that described by Capt. Yolland, who states—"Suppose my body to represent the stand of the instrument, and my two arms held in a horizontal position, a hollow tube passing from one elbow to the other elbow, and the hands to represent two phials or bottles, and these being filled with water, that constitutes a water level."

It is subsequently admitted that this instrument "will not give the same degree of accuracy as the spirit-level will do, because in the one case it is read by telescopic sight, and in the other it is not." But if the same degree of accuracy cannot be attained by this imperfect instrument, why in the name of common-sense make use of it at all?—for anything introduced upon a map as data for important ulterior operations, not having even the pretence of being accurate, had much better not be introduced at all; and it is well known to practical levellers that if even minute errors are permitted to exist in a series of levels, there can be no certainty as to what extent the errors may run, nor can any confidence be placed in such operations.

In the pages of the report above referred to, Capt. Yolland states the expense of contouring to be 4*l.* per square mile, or 10*s.* per lineal mile, making no distinction between what he calls instrumental spirit-levelling and instrumental water-levelling. He also states that the saving of expense if the water-level interpolated contour lines were omitted, would be about 8*s.* per square mile. With this data as to cost, we must be satisfied for the present, and endeavour by an impartial analysis to work out the most accurate results which this data will enable us to arrive at.

Sheet 147 of the six-inch map of Yorkshire, which being an incomplete sheet, embraces only 14 square miles of country, contains by admeasurement about 65 lineal miles of instrumental, and about 453 lineal miles of water-level contours, making a total of 518 lineal miles, equal to 37 lineal miles per square mile in an average of 14 miles. This at 10*s.* per lineal mile, amounts to the sum of 18*l.* 10*s.* per square mile. But the water-level interpolated contours amount to about 32 lineal miles per square mile, and if these were abandoned, 8*s.* per square mile would be saved, consequently, the cost of these 32 miles of interpolated contour lines is 8*s.*, or at the rate of 3*d.* per lineal mile; and as this distance must be twice walked over, once for levelling, and once for surveying, the mere field operation will be reduced to 1½*d.* per lineal mile.

This is certainly a cheap age, but we think it will be difficult to reconcile this estimate with the facts of the case, if these facts could be fairly got at. Let us imagine the cheapest possible "human machine" in the shape of a surveyor, with the cheapest possible mechanical machine in the shape of a "water-level," and two labourers commencing the important operation of contour levelling: with the extravagant expectation of realising 1*s.* 6*d.* per diem for the surveyor, and 1*s.* per diem for each of the labourers,—not a very extravagant amount considering the price of provisions,—we find that the party must level or survey 28 lineal miles per diem. But by dealing even thus liberally with the field parties, there would be nothing allowed for plotting the survey of the contours, for field examination by a superior party, for fixing the numerous levelled starting-points and the check-points to close upon, or for the loss of time, which must be considerable in sending to a distant head-quarter office to ascertain if the work closing upon the various check-points are satisfactory. The superior superintendence, and many other obvious contingencies, are also unprovided for.

But let us take another example, which proves more favourable to the above estimates. Sheet 151 of Yorkshire, being a complete sheet, contains 24 square miles of country: a portion of this sheet has the contours at a fair average distance from each other, but a considerable portion being above the 1200 feet contour line, where the number of contours rapidly decrease, this sheet, as a whole, may be considered to give a minimum quantity of contour lines. This sheet contains by admeasurement, 97 lineal miles of instrumental and 540 lineal miles of water-level contours, making in all 637 lineal miles in 24 square miles, or about 27 lineal miles per square mile upon an average of 24 square miles of country. This, at 10s. per lineal mile, will amount to 13*l.* 10*s.* per square mile, and that on a large average of country.

Any one acquainted with the process of contour levelling, as above described, must admit that 10*s.* per lineal mile is a very low estimate, and we are therefore driven to the conclusion, that either the amount of 4*l.* per square mile must be greatly increased, or the quantity of contouring must be limited to 8 lineal miles per square mile. This amount of contouring in an undulating country, such for example as Ireland and Scotland and the northern counties of England, would seldom amount to more than two or three parallel contours in each square mile, which would be altogether inadequate to develope the features or physical relief of the country, or to afford any considerable assistance in the prosecution of engineering works or of agricultural improvements.

The advocates of contouring, and indeed the Committee on the "Map of Ireland," appear to think that a contoured map would enable an engineer to lay out a railway or other engineering work in his office, as if there were no point of importance to be attended to but that of levels; and seem to fancy that a map which would enable an engineer to do very imperfectly in his office what he could only execute perfectly by a careful study of the ground in walking over it, would be a very great saving to the country. Poor, deluded, well-meaning mortals! as if engineers charged for their various operations in proportion to the length of time in which they are occupied upon them. If a surgeon amputated a limb successfully in ten minutes, and another hacked away without ultimate success for two or three hours, according to these sages, the latter laborious individual would be entitled to a reward in proportion to the time occupied and not to the quality of the work performed.

By a careful examination of the contour lines on Sheet 151, Yorkshire, it will be observed that the instrumental lines show numerous sharp salient points, giving a rugged angular appearance to the ground, which nature never exhibits unless in the most sterile regions where the rock formations crop out to the surface: but wherever the surface is covered over with vegetable earth and verdure, the protruding angles of the bare skeleton are rounded off into the most pleasing undulations.

The water-level contours exhibit no such unnatural angles, and are so far preferable to the instrumental contours. It will also be observed that the contour lines pass over abrupt precipices, which are brought out by shading, without deviating in the slightest degree from the symmetrical form assumed on each side of the precipice, which is a self-evident proof of error. This sheet also contains several large patches of woodland through which the contours are carried with a great amount of uniformity and freedom, evidently at the discretion of the draughtsman, as it would be impossible to contour accurately through a wood without destroying a great portion of it.

One most remarkable circumstance connected with this sheet of the six-inch map, is the fact that by as careful an estimate as can be arrived at without the field notes, of every feature upon the map which has been surveyed, the average of the whole sheet gives about 12 lineal miles of surveying to every square mile of area, whilst the amount of contouring is 27 lineal miles per square mile; and as contouring must first be levelled and then surveyed, the actual amount of work would be 54 lineal miles of contouring, as compared to 12 lineal miles of detailed survey. There is, therefore, more than four times as much contouring work upon the plan as there is of every description of detailed survey; and consequently, if a square mile of contouring can be executed for 4*l*., a square mile of detailed survey can be executed for 1*l*. per square mile, being about ⅜ths of a penny per acre.—These few rough notes may amuse and perhaps edify our readers until the promised Treasury papers appear.

## THE AQUEDUCTS OF CONSTANTINOPLE.*

As water is the only beverage generally used by the Turks, and as moreover the Koran prescribes seven ablutions of the body every day, aqueducts and fountains are objects of an almost religious bearing in the East. Their number in the towns and along the roadsides is constantly increasing, and water is often brought to them from great distances. They have, of late years, been built in a somewhat better style than formerly, and are always pleasing on account of their great utility.

The chief sources which supply the consumption of Constantinople and its suburbs on this side of the harbour are situate on the outrunners of the Balkan (Hæmus) mountains, which terminate on the Canal of the Black Sea near the castles of the Dardanelles. The height of these mountains, at the spot where the sources are situate, is about 800 feet, the distance from Constantinople three miles, and from the shores of the Black Sea three-quarters of a mile. The slopes of this mountain are covered with fine forests of oak and chesnuts on the side towards Constantinople, and are very rich in sources of pure water. The slope towards the Euxine must have been once similarly wooded, but is now quite naked. On the former side, near the village of Belgrad, most stringent regulations for the preservation of the timber, &c. are in force, and for not obstructing the flow of these most valuable springs.

The lateral mountain chains, on which Constantinople is built, divide the western valley of fresh water from the Sea of Marmora, and end at the point of the Seraglio. This chain of mountains has one plateau and two slopes, and on both these deep and extensive plains. It was from the position of these three slopes and the situation of Constantinople, that three systems of water conduits have been established. Part of the supply has also been derived from Dshebedshe-Kioi, which unites itself with that of Alibeg-Kioi about 1½ mile from the Justinian Aqueduct. The situation of the Turkish capital demanded, moreover, that the waters were to be taken up as high as possible, that they might be conveyed, at the minimum expense, to the different points of distribution. Another feature in this hydraulic problem to be solved was, to find on the water-shed in the direction of the great Bend (reservoir) from Belgrad to the Takssim of Egri-Kapu, a point, which was situate on the incline required for the flow of the water,—a point, to which both the waters of the valley of Belgrad and Aiwat-Bendi could be conducted, and whence it could be brought to the Takssim of Egri-Kapu. This object was achieved by the construction of a reservoir of circular form (Bash-Hawus), situated in the embouchure of a small valley sloping towards the Alibeg-Kioi valley. The valley of Pyrgos was crossed by means of an aqueduct called the long one, extending to 2000 feet. The waters of Belgrad stream forth at the end of the valley from three sources; they soon, however, unite, and fall into a very handsomely built reservoir. The little valley of Pasha-Deressi has also its reservoir and aqueduct. Two other aqueducts take up the waters of the Belgrad and Aiwat-Bendi, and conduct it to the Bash-Hawus of Pyrgos. A third conduit, which starts from the same Bash-Hawus, brings these united streams to the heights of the Alibeg-Kioi valley, where they are carried over to the Aqueduct of Justinian. The latter is a superior work of hydraulic architecture, and undoubtedly the finest left us from the middle ages.

The Takssim at Banari is connected with the Aqueduct of Valens; it lies 53 feet below the upper part of the latter, consequently these two aqueducts belong to two quite different systems. Most writers, amongst whom is Gyllius, who has been continually copied, assert that the Aqueduct of Valens receives the water coming from Belgrad, which is erroneous.

The Takssim of Sta. Sophia furnishes the seraglio of the Sultan with water. After the stream has passed underneath the Hôtel of the Mint, it fills a cistern in one of the courts of the Harem, whence it is raised by what is here called a "Norin," and then discharges itself at Tap-Kapussi in a basin, which is said to be 170 feet long and 150 feet broad, and on which plies a boat for the private recreation of the Sultan.

These various streams are carried to the metropolis through a number of aqueducts, of which the following may be mentioned. The Crooked Aqueduct, the Long Aqueduct, and that of Justinian, are situate near the village of Pyrgos. Their plan forms an equilateral triangle, of which that from the Long Aqueduct to that of Justinian forms the base, upwards of 2½ miles long, while the other two sides, which unite in the Crooked Aqueduct, have each a length of nearly two miles.

The Crooked Aqueduct of Pyrgos receives the water coming from the valley of Belgrad. It consists of two branches, the one 400 feet long, and the other branch, forming nearly a right angle with the previous one, and passing over the valley of Pyrgos from one slope to the opposite one, is 720 feet long. The latter branch consists of a triple row of arcades, whose openings widen and enlarge towards the top, obviously imparting to the building a greater strength than if the arches were placed perpendicularly above each other. The height of the aqueduct from the level of the water in the valley to the top is 114 feet, and above the third tier of arcades is the canal, covered with slabs of stone to exclude the rain water. This aqueduct cannot be of very ancient date, as the lower tier of arches is pointed. Although this structure has no fine external appearance of dressed stones, &c., it still presents a pleasing view from the proportion of its parts and the regular arrangement of its materials. The pyramidal shape of the walls from below upwards, has contributed to effect in all parts of the aqueduct that equilibrium of resistance with the least vertical pressure,—so much so, that all accessory iron bands have been dispensed with.

The Long Aqueduct is, perhaps, of a more imposing character, on account of its great length, but is far inferior to the former, as well in the grace of design as in the choice of materials, and has moreover experienced considerable damage. This aqueduct has probably been rebuilt by the Turks, after the decay of the previous structure. It consists of two tiers of pointed arches, forty-eight in the lower and fifty in the upper story. Its length is 2327 feet, and height 84 feet.

Reservoirs or basins are called at Constantinople Bash-Hawuss, which, mostly of a circular form, are placed in ravines for collecting the waters which have strayed away from their course, and for giving them the direction they have to take. The waters are collected in vaulted viaducts, and by such they flow off, and a third similar conduit brings the water to the natural stream, if the basin is full. The waters of the Crooked and the Long aqueduct flow to the Bash-Hawus of Pyrgos, in two vaulted conduits, and pass combined into one stream to the Justinian Aqueduct.

The Justinian Aqueduct is led over a valley, in which flows the Kydaris of the ancients, and consists of two tiers of large pointed arches, those of the lower being 16·88 mètres in the clear; those of the upper tier have a span of 13·11 mètres. These arches are divided by pillars, which are pierced at three different heights by small arches, which, without endangering the solidity of the structure, diminish the expense of construction, and impart an air of great lightness to the monument. The pillars of the second tier are, moreover, pierced in the whole length of the aqueduct by a vaulted passage 1·3 mètre broad, which has also for its object to make the structure lighter, and to be used as a communication from one side of the valley to the other. The length of the Justinian Aqueduct is 833·88 mètres, its height 35·08 mètres, and the pillars at their base are 16·56 mètres thick. The canal is 0·65 mètre broad, and 1·23 mètre high, and also covered by stone slabs, sloping at each side. This aqueduct is built in an exceedingly solid manner, and although the Turks have paid but very little attention to its preservation, it has now withstood the action of many centuries. This and the Crooked aqueduct are the most remarkable works left by the Greek emperors. Although this aqueduct is now called the Justinian, it does not appear that it was built by that monarch, as Procopius, in his work 'On Buildings,' which dilates on those erected by Justinian, does not mention the aqueduct. Other authors have ascribed it to Andronicus Comnenus, who was elected Emperor in 1183, but did not reign more than two years.

The Aqueduct of Valens (Aquæductus Valentianus) transects the valley formed by two of the hills on which Constantinople is built. It consists of hewn stones, and is of a very imposing aspect. Originally it had two tiers of arcades, the upper, however, being removed for the sake of obtaining a better view of the

* Abridged from the 'Allgemeine Bauzeitung.'

Mosque of Sheh-Sadeh. What remains of that aqueduct extends to a length of 2040 feet, and its height is 74 feet. It is conjectured, that the structure when complete, extended to the length of three-quarters of a mile. This aqueduct was begun by the Emperor Hadrian, before the foundation of Constantinople, re-constructed by Valens, destroyed by the Avares, and re-erected by Soliman the Splendid.

Conjointly with these aqueducts there are a number of reservoirs, by means of which the water is distributed in the different quarters and districts of Constantinople. The most important and most handsome is that of Dsheni-Bagtshi. We were astonished, at first, that those buildings, some of which are under ground, and form walls against which the silt water is constantly exercising its influence, have not experienced any deterioration during the many centuries since they have been erected. Their inner walls are so smooth, the courses of stone so well united, the vaults so complete, that they appear as if cut in one piece; and it is difficult to conceive how this has been the case without any care whatever having been bestowed on these buildings by their present Moslem owners.

## COMMISSION FOR THE PRESERVATION OF ARCHITECTURAL MONUMENTS IN AUSTRIA.

The honour of having appointed an official commission for the preservation of monuments, belongs to the government of Louis Philippe, which first instituted the Paris Commission des Monuments. Austria has now followed in the same course, although both the extent and value of its historical monuments, and its financial means, are much inferior to those of France. The seat of the central commission is in Vienna, while conservators are to be appointed in the capitals of the provinces, Buda-Pesth, Prague, Milan, &c. The conservators have to obtain information on all architectural monuments of their district, and to collect all documents, drawings, and engravings relating thereto. For this purpose they have to keep a register of all architectural monuments of their district which possess either an artistic, scientific, or historical interest. Then follow some instructions as to the preservation of such structures, and also the precautions to be observed in the search after and discovery of hitherto unknown monuments. All moveable objects discovered in excavations, &c., are to be purchased from the owners by the Imperial Museum of Antiquities, at Vienna. In all cases where grants of money are required, for either the preservation of or search after historical or art monuments, the conservators have to apply to the central commission, which, being part of the Ministry of Public Works, will take the necessary steps in furthering such objects of public utility.

## DECORATIONS OF THE NEW PALACE, AT WESTMINSTER.

A Return to an Address of the House of Commons has been printed, giving an "Account of the Amount of all Commissions for Works of Art to various Artists for the Decoration of the New Palace of Westminster, from its Commencement to the Present Time, with the Estimate for each Work; also, a Return of the several Salaries to Artists holding Appointments under the Royal Commission for Decorating the New Palace of Westminster." The return also shows the Receipts and Expenditure of the various Exhibitions which took place, under the direction of the Commissioners, in Westminster Hall and elsewhere, in order to distinguish certain premiums and purchases, the cost of which was furnished from the receipts of such Exhibitions, from the amount provided for similar objects by the Treasury.

House of Lords.—The decorations in the House of Lords, executed under the direction of Her Majesty's Commissioners on the Fine Arts, included six Fresco Paintings for the end walls, and eighteen Metal Statues of Barons and Prelates for the niches on the four sides. By adopting the modern invention of casting statues in zinc, coated with copper by the electro process, and chemically tinted as required, an invention carried to great perfection, consistently with cheapness, in Berlin, a saving may be effected on the estimate. It is proposed that such surplus be carried to a fund for "Sundry Works," the Commissioners having, in some instances, been unable, for want of such a fund, to institute experiments, or to meet the cost of unforeseen alterations without increasing the first estimates.

The superintendence of the Commissioners, with regard to the Stained Glass Windows, was limited to the selection of the Royal Personages represented, and, in consequence of a competition (June 1844), to the recommendation of the artists. The style of design and colour in the windows, in its required adaptation to the place, and as affecting the light, was left to the architect.

*Fresco Paintings.*

| SUBJECTS. | ARTISTS. | DATE AND ESTIMATE. |
|---|---|---|
| Religion ... ... ... | J. C. Horsley | The "Baptism of Ethelbert," the first fresco executed in the House of Lords and in the Palace of Westminster, was completed August 1846.<br>The frescoes of "Chief Justice Gascoigne" and "Justice," the two last executed in the House of Lords, were completed Dec. 1849.<br>Estimated at 800*l.* for each entire work; 400*l.* for the cartoon, and 400*l.* for the fresco. |
| Justice ... ... ... | Daniel Maclise, R.A. | |
| The Spirit of Chivalry ... | Daniel Maclise. R.A. | |
| The Baptism of Ethelbert | Wm. Dyce, A.R.A. | |
| Prince Henry, afterwards Henry V., acknowledging the Authority of Chief Justice Gascoigne | C. W. Cope, R.A. | |
| Edward the Black Prince receiving the Order of the Garter from King Edward III. ... ... | C. W. Cope, R.A. | |

*Remarks.*—Of the six artists above named, commissioned to furnish designs for these subjects, and whose works were exhibited in Westminster Hall in 1845, four were thus selected. This afforded an opportunity of preserving a uniformity of style in the two outside frescoes on each side, such frescoes having been executed respectively by one artist.

*Metal Statues of Eighteen Barons and Prelates who co-operated in obtaining Magna Charta.*

| SUBJECTS. | ARTISTS. | DATE AND ESTIMATE. |
|---|---|---|
| 1. Stephen Langton, Archbishop of Canterbury. | *Gilder*—F. Draycott.<br>J. Thomas, *Modeller* | The model for the statue of Wm. Earl of Arundel, was the first completed, December 1848.<br>The model for the statue of William de Mowbray was the last completed, May 1851.<br>The statue first cast was that of Hubert de Burgh, July 1850.<br>Eleven remain to be cast.<br>The price of the eighteen models was estimated at 150*l.* each, making 2700*l.* The price of casting, after the cost of the first experiment, was estimated at 110*l.* each statue, making 1980*l.*; that sum was accordingly appropriated for the purpose from a Parliamentary grant. But as the estimated cost at 110*l.* each statue, would not include the gilding, various metal founders were consulted, and various methods tried, with a view to diminish the expense of casting. The Commissioners ultimately agreed, May 1852, to pay Messrs. Elkington 80*l.* per statue, the material being zinc, coated with copper by the electro process, and bronzed. By this arrangement more than sufficient will remain from the original estimate to cover the cost of gilding, estimated at 10*l.* 10*s.* per statue. |
| 2. Henri de Londres, Archbishop of Dublin. | J. E. Thomas, *Mod.*<br>Moore, Fressange, & Co., *Casters.* | |
| 3. Almeric, Master of Knights Templars | P. M'Dowell, *Model.*<br>Elkingtons, *Casters.* | |
| 4. William, Earl of Salisbury. | J. Thomas, *Modeller.* | |
| 5. William, Earl of Pembroke. | J. E. Thomas, *Mod.* | |
| 6. William, or Waryn, Earl of Warren. | P. M'Dowell, *Model.*<br>Elkingtons, *Casters.* | |
| 7. William, Earl of Arundel. | W. Woodington, *Mo.*<br>Moore & Co., *Casters* | |
| 8. Hubert de Burgh, Earl of Kent. | W. Woodington, *Mo.*<br>Moore & Co., *Casters* | |
| 9. Richard, Earl of Clare. | Henry Timbrell (deceased), *Modeller.* | |
| 10. William, Earl of Aumerle. | J. S. Westmacott, *Modeller.* | |
| 11. Geoffrey, Earl of Gloucester. | J. S. Westmacott, *Modeller.*<br>Elkingtons, *Casters.* | |
| 12. Saher, Earl of Winchester. | J. S. Westmacott, *Modeller.*<br>Elkingtons, *Casters.* | |
| 13. Henry, Earl of Hereford. | J. Thorneycroft, *Modeller.* | |
| 14. Roger, Earl of Norfolk. | J. Thorneycroft, *Modeller.* | |
| 15. Robert, Earl of Oxford. | F. Thrupp, *Modeller.* | |
| 16. Robert Fitswalter ... | F. Thrupp, *Modeller.* | |
| 17. Eustace de Vesci ... | A. Ritchie, *Modeller.* | |
| 18. William de Mowbray | A. Ritchie, *Modeller.* | |

Upper Waiting Hall.—The decorations are at present limited to Frescoes. The object was to test the powers of artists, otherwise eligible, in the treatment and execution fitted for fresco-painting. With regard to the choice of subjects, it having been originally proposed to place eight statues of poets in the apartment, the illustration of each poet by a scene from his works at once suggested itself, while the scope thus afforded to the artists would, it was thought, enable them to make their trials with advantage. That advantage, it must be confessed, is more than counterbalanced by the very imperfect light in the room, a defect most apparent at that season of the year when the works can be carried on with least interruption. Most of the artists have, in consequence, been compelled to paint there by gas-light.

The "Remarks" on the subject of the metal statues for the

House of Lords, as to the expediency of providing a fund for "Sundry Works," in order to meet the cost of occasional alterations, and that of works which might be set aside, are applicable in the present instance.

*Frescoes.*

| SUBJECTS. | ARTISTS. | DATE AND ESTIMATE. |
|---|---|---|
| Chaucer: "Griselda's First Trial of Patience." | C. W. Cope, R.A. | The fresco of "Griselda" and that in illustration of Milton were completed respectively in October and November 1848.<br>The fresco in illustration of Pope was completed November 1852.<br>Those in illustration of Scott and Byron were not completed when this Return was called for, Aug. 1853.<br>The cost of each painting was estimated at 400*l*., 200*l*. for the cartoon, and 200*l*. for the fresco. The amount would therefore be 3200*l*. But one artist, after having completed his cartoon, for which he received 200*l*., was not invited to execute the fresco. Another had completed his cartoon, when the Commissioners thought it advisable to change the subject, and a compensation of 100*l*. was, under the circumstances, accepted by the artist.<br>The sum of 300*l*. was therefore added to the original estimate, making 3500*l*. |
| Spencer: "St. George overcoming the Dragon." | G. F. Watts. | |
| Shakspeare: "Lear disinheriting Cordelia." | J. R. Herbert, R.A. | |
| Milton: "Satan touched by Ithuriel's Spear." | J. C. Horsley. | |
| Dryden: "St. Cecilia."... | J. Tenniel. | |
| Pope: "The Personification of Thames." | E. Armitage. | |
| Scott: "The Death of Marmion." | E. Armitage. | |
| Byron: "The Death of Lara." | C. W. Cope, R.A. | |

St. Stephen's Hall.—The decorations proposed are Statues and Frescoes. The decorations are at present limited to Statues. The Commissioners have expressed the opinion, "that as St. Stephen's Hall stands on the spot where the House of Commons was, during many centuries, in the habit of assembling, it should be adorned with statues of men who rose to eminence by the eloquence and abilities which they displayed in that House. Twelve personages selected on this principle were accordingly named in the Fourth Report of the Commission to Her Majesty."

In this, as in others cases, the estimate is limited to works actually commenced. The statues in St. Stephen's Hall being by various artists, the entire series (consisting of twelve personages) may be completed without interruption or not, as may be thought advisable.

The Commissioners have determined that the chronological order of subjects, or of personages, in the corridors or halls connected with the Central Hall, should begin from that hall. In the ultimate arrangement of the statues in St. Stephen's Hall, the figure of Selden will therefore be the first on the right in quitting the Central Hall.

*Marble Statues.*

| SUBJECTS. | ARTISTS. | DATE AND ESTIMATE. |
|---|---|---|
| Selden ... ... | ... J. H. Foley, A.R.A. | The statues of Lord Clarendon and Lord Falkland were completed in January 1848; that of Hampden in October 1850. The other five statues, for which commissions have been given, are not yet completed.<br>The first three statues were estimated at 1200*l*. each, making 3600*l*. The estimate is now reduced to 1000*l*. per statue; the cost of the eight statues will therefore be 8600*l*. The cost of the twelve would be 12,600*l*. |
| Hampden ... | ... J. H. Foley, A.R.A. | |
| Lord Falkland ... | ... John Bell. | |
| Lord Clarendon ... | ... W. C. Marshall, R.A. | |
| Lord Somers ... | ... W. C. Marshall, R.A. | |
| Sir Robert Walpole | ... John Bell. | |
| Lord Chatham ... | ... P. M'Dowell, R.A. | |
| Lord Mansfield ... | ... E. H. Bailey, R.A. | |
| Burke | | |
| Fox | | |
| Pitt | | |
| Grattan | | |

The Prince's Chamber.—The decorations proposed for this apartment are Statues, Bas-Reliefs, either in wood or in some more durable material, portraits of the Tudor Family, and Tapestries. The decorations are at present limited to Statues and Bas-Reliefs.

This apartment was first called the Lobby to the House of Lords; then the Victoria Hall; and finally the Prince's Chamber (the ancient designation of a corresponding room). According to the architect's first design, the apartment did not exist, as it formed part of the Royal Gallery, first called the Victoria Gallery. The earlier Reports, in alluding to the decorations of the Victoria Gallery, consequently comprehend a portion of those of the room now called the Prince's Chamber.

The previous remarks on the expediency of providing a fund for "Sundry Works" are again applicable in the present instance. The Commissioners had proposed to fill certain narrow panels in this room with portraits of the Tudor Family, 28 in number, executed in a style corresponding with the peculiar form of the compartments, and with the periods to which the personages belonged. The specimens submitted did not, however, meet the views of the Commissioners as to the requisite treatment. The sum of 50*l*. paid by agreement for one of such portraits, afterwards set aside, might have been included in "Sundry Works."

*Statues.*

| SUBJECT. | DATE AND ESTIMATE. |
|---|---|
| A Statue of Her Majesty, with Figures of Justice and Clemency, and with Bas-reliefs on the Pedestal.—J. Gibson, R.A., *Artist*. | The small model was approved by the Commissioners, July 1850. The statues, to be executed in Rome, are not yet completed. Estimate 3835*l*. |

The place which this work of sculpture is to occupy is the recess on the north side of the apartment.

*Models for Bas-Reliefs, and one experimental Portrait.*

| SUBJECTS. | DATE AND ESTIMATE. |
|---|---|
| In the two compartments on the East and West sides:<br>1. The Field of the Cloth of Gold.<br>2. The Visit of Charles V. to Henry VIII.<br>In the three compartments on the South side, West of the door:<br>3. The Escape of Mary Queen of Scots.<br>4. The Murder of Rizzio.<br>5. Mary looking back on France. (The Escape of Mary occupying the centre panel.)<br>In the three compartments on the South side, East of the door:<br>6. Queen Elizabeth Knighting Drake.<br>7. Raleigh spreading his Cloak as a Carpet for the Queen.<br>8. The Death of Sir Philip Sidney. (The subject of the knighting of Drake occupying the centre panel.)<br>On the North side:<br>9. Edward VI. granting a Charter to Christ's Hospital.<br>10. Lady Jane Grey at her Studies.<br>11. Sebastian Cabot before Henry VII.<br>12. Catherine of Arragon Pleading. | Wm. Theed is the Artist to whom the series of models is entrusted.<br>The model No. 8, the "Death of Sir Philip Sidney," was completed July 1852.<br>Nos. 3, 5, 7, 9 and 10 are also completed. Another artist had been previously commissioned to execute the work; but after furnishing three models, he was not invited to proceed, and the specimens were set aside.<br>The cost of each model was estimated at 50*l*., the amount for the 12 would therefore be 600*l*. But the three models furnished by the artist first employed, and for which he received 150*l*., having been set aside, the cost of the entire series requires to be estimated at 750*l*.<br>The models referred to will ultimately be executed, either in wood or in some more durable material. The estimate for such ultimate works will depend on the material. |

The Queen's Robing Room.—The decorations proposed by the Commissioners for this apartment are limited to Fresco Paintings. A Committee, consisting of nine members of the Commission, observe in their Report (adopted by the Commission generally), that, "influenced by the considerations before expressed as to the expediency of varying the character of the decorations proposed," they "were of opinion that a series of paintings illustrating the Legend of King Arthur would be appriopriate in this locality; and your Committee unanimously agreed to recommend to the Commission that the execution and entire superintendence of such decorations should be entrusted to Mr. Dyce, who had already executed a fresco in the House of Lords."

*Fresco Paintings.*

| SUBJECT. | DATE AND ESTIMATE. |
|---|---|
| The Legend of King Arthur, W. Dyce, R.A., *Artist*. | The agreement dates from July 1848. The work is in progress.<br>The agreement provides that the artist shall receive a salary of 800*l*. a year for six years, making 4800*l*.<br>The artist would also by the agreement have been entitled to the above amount had the work been completed in less than six years. |

The term of six years, dating from the 1st July, 1848, was at first fixed, as the introduction of a work in sculpture in a compartment on the west side of the room was then contemplated, and such an arrangement would have reduced the number of fresco paintings; but the Commissioners having subsequently decided that the whole of the available wall-space should be filled with frescoes, the time was prolonged, by the conditions of the agreement, accordingly, and it may be necessary to extend it still more.

Mr. Dyce is the only artist employed in the decoration of the Palace of Westminster, who for a limited time, receives a salary.

THE PEERS' ROBING ROOM.—It is proposed that the decorations in this apartment (as yet not built) shall be limited to Fresco Paintings. The Committee before referred to, after expressing their opinion "that Scripture subjects, as affording scope for the highest style of design, and as being especially eligible on other grounds, should by no means be excluded, considered that the above-named locality, in which the principal compartments intended for painting are of considerable magnitude, would be well adapted for such subjects. Your Committee were of opinion that the illustrations should have reference to the idea of Justice on Earth, and its development in Law and Judgment, and that the following subjects would be appropriate."

The foundations of the Peers' Robing Room have been only recently built; but as in fresco-painting a considerable time is required for the preparation of designs, cartoons, and coloured studies, the Commissioners deemed it expedient to engage and employ the artist at the period mentioned, so as to give him ample time for such preparatory labours.

*Fresco Paintings.*

| SUBJECTS. | DATE AND ESTIMATE. |
|---|---|
| In the single compartment, on the West side:<br>1. Moses bringing down the Tables of the Law to the Israelites.<br>In the two small compartments on the East side:<br>2. The Fall of Man.<br>3. His Condemnation to Labour.<br>On the South side, in the larger compartment:<br>4. The Judgment of Solomon.<br>In the two smaller:<br>5. The Visit of the Queen of Sheba.<br>6. The Building of the Temple.<br>On the North side, in the larger compartment:<br>7. The Judgment of Daniel.<br>In the two smaller:<br>8. Daniel in the Lions' Den.<br>9. The Vision of Daniel. | John Rogers Herbert, R.A., is the Artist to whom these works are entrusted.<br>The agreement with Mr. Herbert was concluded in July 1850. His first design for the subject of the Judgment of Daniel was approved by the Commissioners, May 1851.<br>The work to be completed in nine years, or less, dating from the 1st April 1851. Estimate 9000*l.* |

THE PEERS' CORRIDOR.—The decorations proposed for this corridor, containing eight compartments, are Historical Oil Pictures. The Committee before referred to "were of opinion that the corridors which join the two Houses might properly be decorated with paintings illustrative of that great contest which commenced with the meeting of the Long Parliament, and terminated in 1689. It will be seen that the subjects have been selected on the principle of parallelism, and that an attempt has been made to do justice to the heroic virtues which were displayed on both sides.

*Oil Paintings.*

| SUBJECTS. | | SUBJECTS. |
|---|---|---|
| 1. Charles erecting his Standard at Nottingham. | Opposite | 2. Speaker Lenthal asserting the Privileges of the Commons when the attempt was made to seize the Five Members. |
| 3. Basing House defended by the Cavaliers against the Parliamentary Army. | Opposite | 4. The setting out of the Train Bands from London to raise the Siege of Gloucester. |
| 5. The Expulsion of the Fellows of a College at Oxford for refusing to sign the Covenant. | Opposite | 6. The Embarkation of a Puritan Family for New England. |
| 7. The Burial of Charles I. | Opposite | 8. The parting of Lord and Lady Russell. |

The artist at present invited to undertake this work has not, as yet, furnished the design required by the Commissioners.

The estimate is 3650*l.*; 500*l.* for the first picture, and, in the event of the artist being commissioned to execute the remainder, 450*l.* for each remaining picture.

THE COMMONS' CORRIDOR.—Consisting of eight compartments, in which Historical Oil Pictures are proposed to be placed. See the observations of the Committee before quoted in reference to the Peers' Corridor.

On the chronological order of the subjects, *see* the remarks on St. Stephen's Hall. The picture of the Execution of Montrose will be fixed in its place when the artist shall have completed that of the Sleep of Argyll, on which he is now employed, in order that the two may be seen together. The picture of the execution of Montrose, the first executed, was completed March 1853. The Estimate is 3650*l.*; 500*l.* for the first picture, and 450*l.* each for the remainder. Edward M. Ward, A.R.A., is the Artist.

*Oil Paintings.*

| SUBJECTS. | | SUBJECTS. |
|---|---|---|
| 1. Charles II. assisted in his Escape by Jane Lane. | Opposite | 2. Alice Lisle concealing the Fugitives after the Battle of Sedgemoor. |
| 3. The Executioner tying Wishart's Book round the neck of Montrose. | Opposite | 4. The Sleep of Argyll. |
| 5. Monk declaring for a Free Parliament. | Opposite | 6. The Acquittal of the Seven Bishops. |
| 7. The Landing of Charles II. | Opposite | 8. The Lords and Commons presenting the Crown to William and Mary, in the Banquetting House. |

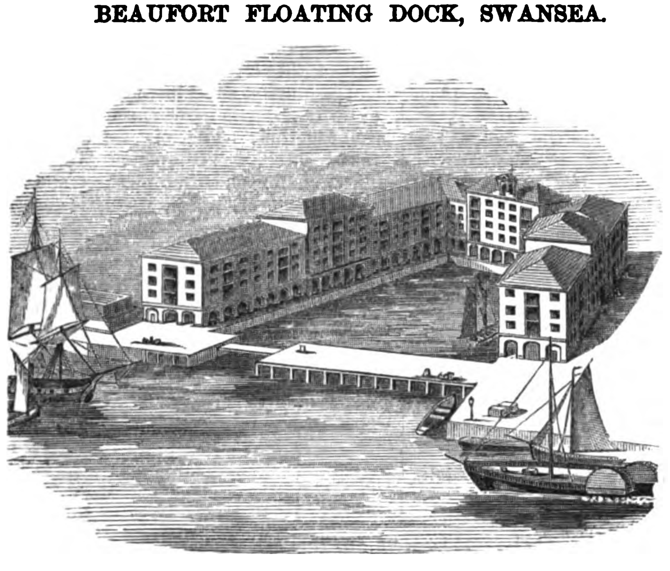
*Sundry Works.*—This item in the estimates is intended to provide a small fund for experiment or extra works, in order to avoid, as far as possible, the alteration of more important estimates. It has been seen, in the case of the frescoes for the Upper Waiting Hall, and in the case of the bas-reliefs for the Prince's Chamber, that works may from various causes sometimes be set aside. Under such circumstances, it would be desirable to meet the additional outlay by means of a fund of the above description. Such an arrangement has been only recently proposed; it appears for the first time in the Estimates for the year ending 31st March 1852, but it is only in the Estimates for the present year that part of the sum required, happening to come within the usual vote, has been granted: that sum is 100*l.* The Commissioners had already set apart the sum of 120*l.* for the same object from a grant for the year ending 31st March 1851. The only payment hitherto made under this head was in September 1852, when 50*l.* was paid to an artist as a remuneration for his time, according to agreement; a sketch which he had been invited to submit not having been approved. The fund for "Sundry Works" amounts therefore at present to 170*l.*

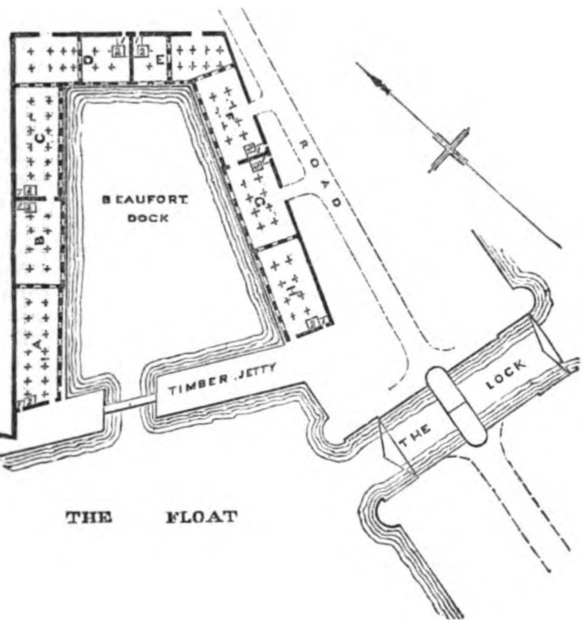
*Salaries to Artists.*—Referring to that part of the requisition calling for "a Return of the several salaries to artists holding appointments under the Royal Commission for decorating the New Palace of Westminster," it has been already stated in the Return relating to the Queen's Robing Room, that William Dyce, R.A., is the only artist employed in the decoration of the Palace of Westminster who, for a limited time, receives a salary. No other artist, in any way connected with the Commission, has a salary, except the secretary, who had the honour to be appointed by her Majesty. The secretary at present receives 750*l.* a year, out of which he pays an assistant and clerks.

## THE MUNICH PALACE OF THE GREAT INDUSTRIAL EXHIBITION.

AFTER many preparatory studies and investigations of the Committee appointed for that purpose, it has been proposed and accepted that the Munich Crystal Palace shall be erected on the north side of the botanical gardens. The locality is well chosen, as it is lighted on all sides by the uninterrupted rays of the sun, the whole area extending to 480,000 square feet. As it is intended that the building should be converted, after its temporary use, into winter, or rather botanical conservatories, the construction has been adapted thereto. The area of the Industrial hall is calculated at 160,000 square feet. The plan has been designed by M. Voit, the architect of the new Pinakotheka. The chief entrance will be from Arûr-street, which lays in a line with the north entrance of the transept. The building is to be completed in June next, reckoning thirty days for the erection of the ironwork, and as many for the glazing. The outer circumference will be constructed of a solid wall, and the lateral naves will be formed of iron columns, supported by a foundation of brick and cement.

## BEAUFORT FLOATING DOCK, SWANSEA.






The Trustees of the Harbour of Swansea have lately formed a part of the port into a floating dock, and have impounded for that purpose an extent of water of between nine and ten acres. The Duke of Beaufort, as the owner of a piece of land bordering on the above float, has caused a side excavation to be made to the same depth of water as the floating dock, fronted by a timber jetty, leaving an open water-way 40 feet in width, and having access from the general float, thus forming a private berthage for six or eight first-class vessels, entirely out of the way of the general traffic of the float. This private dock is surrounded on three sides by eight stacks of substantial warehouses, each stack being provided with a staircase, and inclosed with brick partitions the whole height; the upper floors are calculated to carry the weight of any goods usually stored on timber floors. The total contents of the warehouses, exclusive of the wharfage on the timber jetty, are 1,239,257 cubic feet, and 116,200 feet superficial area. The ground story or quay is paved with Pennant stone, grouted and bedded on river shingle, filled-in on a bed of concrete. The walls stand on a mass of concrete, in some places upwards of 16 feet deep. They are built in rubble-work, with excellent sandstone from the local quarries, the facing being random-range work, with ashlar angles, reveals, piers, and arches, all hammer-dressed. A moulded string runs round the top of the arcade, and divides the ashlar work of the piers and arches from the random-range work of the face of the walls above, which are crowned by a bold but plain cornice. The lime used throughout the building is blue lias, from the sea beach at the Abershaw quarries.

The floors are carried by fir solid girders and iron stanchions, the bases of which are bedded on the caps of those next immediately beneath. The window-sashes are of iron. Messrs. Haward and Nixon, of London, are the builders.

Swansea, as is well known, is the chief seat of the copper smelting business, and has already a large trade with Australia, and other foreign parts, and is connected with the Glamorganshire iron works, and steam coal collieries at Aberdare and Merthyr, by the South Wales and Vale of Neath Railways. It has also a communication with the tin-plate works and works for smelting silver ores in Swansea Valley, by a canal of sixteen miles in length.

The Port of Swansea offers great facilities for repairing vessels, having already one patent slip and three dry docks; there are also in progress eighteen acres of wet docks, consisting of a half-tide basin and inner dock, which will be completed in about eighteen months.

The annexed engravings represent a general view of the Beaufort Docks, and a plan of the same, together with the float; the figures 1, 1, are staircases, and 2, 2, counting-houses.

## IRON ROOF FOR SMITHFIELD MARKET, MANCHESTER.

F. R. Wheeldon, *Engineer*, Derby.

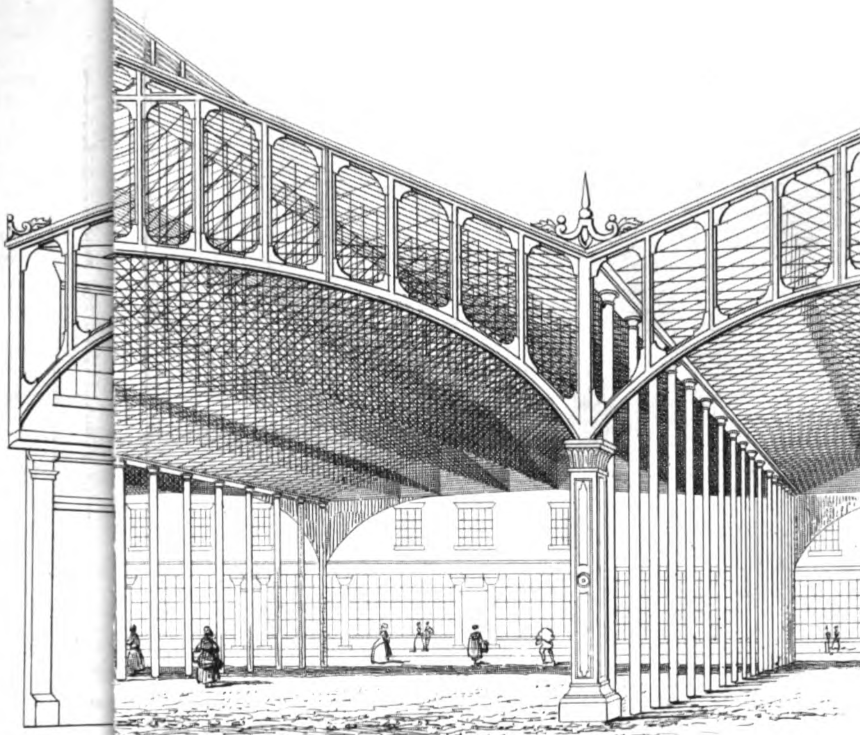
(*With Two Engravings, Plates* XII. *and* XIII.)

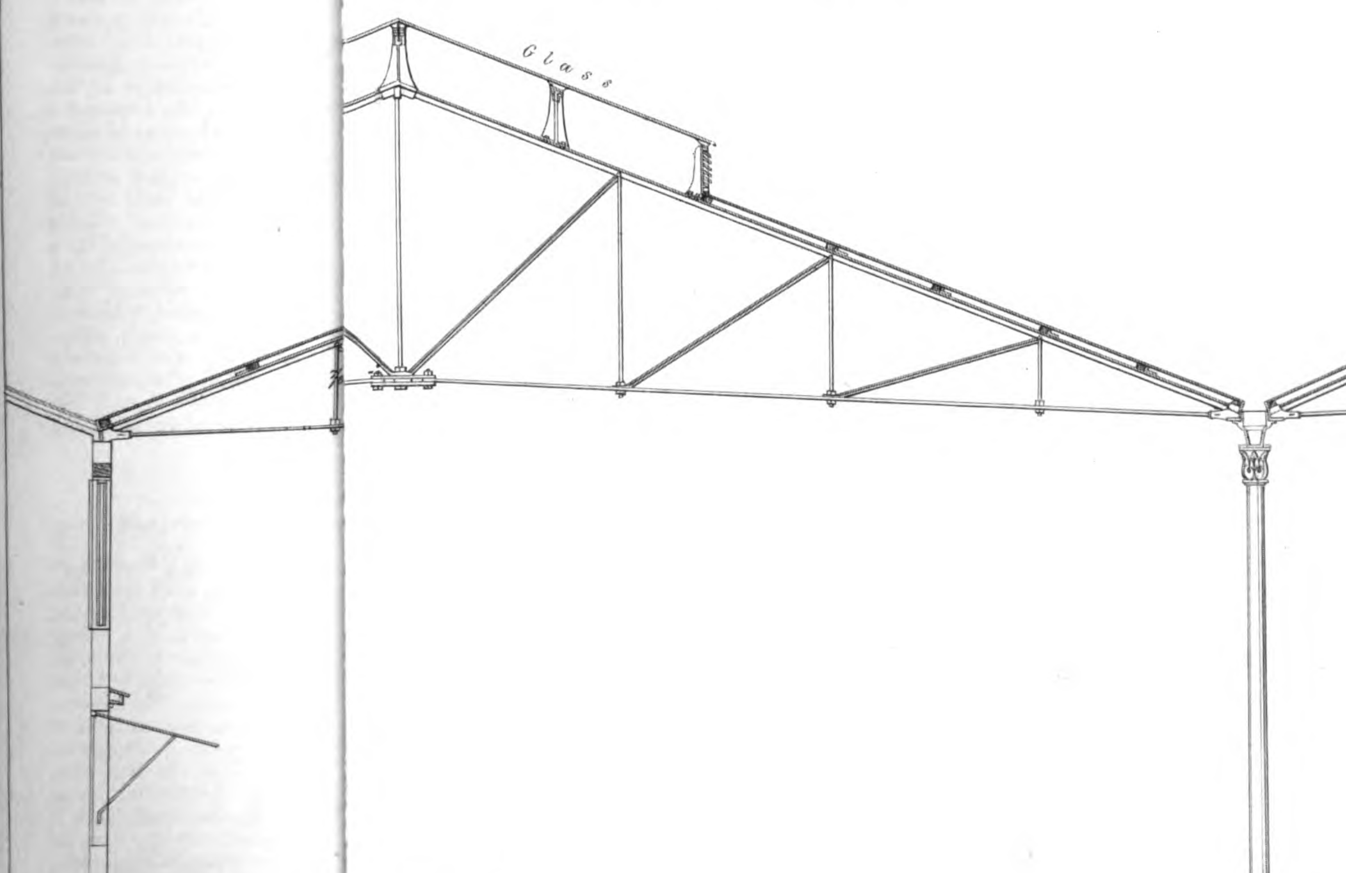
The space to be covered over by the iron roof is 440 feet long by 244 feet wide. It is composed principally of wrought-iron, and consists of two central spans of 72 feet each, and two side spans of 50 feet each. The whole is supported by cast-iron gutter-girders, of an average length of about 23 feet each, resting on columns about 25 feet high. At the apex of each roof is a skylight 15 feet wide on each side of the ridge, running the whole length of the market, and supported on louvre framing, by which ample ventilation is secured. The total area of glass is upwards of 60,000 square feet. The rain-water is conducted down each column into drains laid for the purpose; the girders or gutters are provided with an outlet at each end, for the discharge of the rain-water into the columns. And in fixing on the columns a space of a quarter of an inch is left between each, so as to allow of the expansion and contraction of the metal, and obviate the continual leakage from the breaking of joints, so common in long lengths of metal guttering. The meeting of the ends of the gutters on the columns is concealed behind cast-iron shields bearing the City Arms. One side of the market is bounded by a line of shops looking into the market, the other side will be an open arcade, consisting of 18 arches, resting on columns with foliated capitals. Each end of the market is finished with four ornamental elliptical arched screens, filled in with rough plate-glass, and springing from square open pillars with enriched capitals. The gable ends of each roof are finished with antefixes.

Mr. James Haywood, of Derby, is the contractor, and Mr. Wm. Fairbairn has been appointed by the Committe consulting engineer.

*Pendulous Reciprocating Steam Engine.*—A novel and cheap steam engine has lately been invented under the above title. It is "an eccentric revolving on its own diameter," in a "cylinder" or steam chamber suspended as a pendulum, the shaft on which the eccentric piston is keyed, being the main or driving shaft, and makes upwards of 100 revolutions per minute in a thirty horse engine. The principle of this engine is similar to the ordinary engine but it works with much less friction; a thirty horse high pressure will work with one pound of steam. "An eccentric revolving on its own diameter" contains the two motions of the ordinary engine, viz., rectilinear and revolving, though so amalgamated as to be hardly distinguishable. It has been received favourably by the Lords of the Admiralty, being especially adapted for screw propulsion, from the small space it occupies and the speed that can be obtained direct. The inventors and patentees, Messrs. Shiptons and Simpson, engineers, Manchester, obtained a medal at the Exhibition of 1851, since which great improvements have been made by them.

ONE



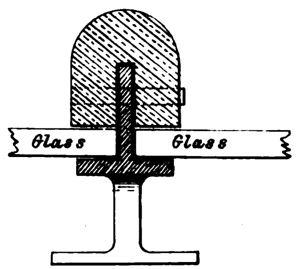



Scale 1/8" = Foot.

J.R.Jobbin

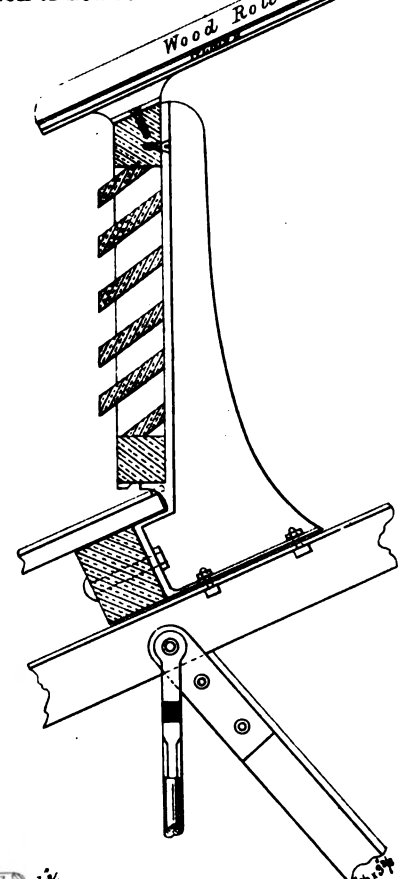
SMITHFIELD MARKET, MANCHESTER.

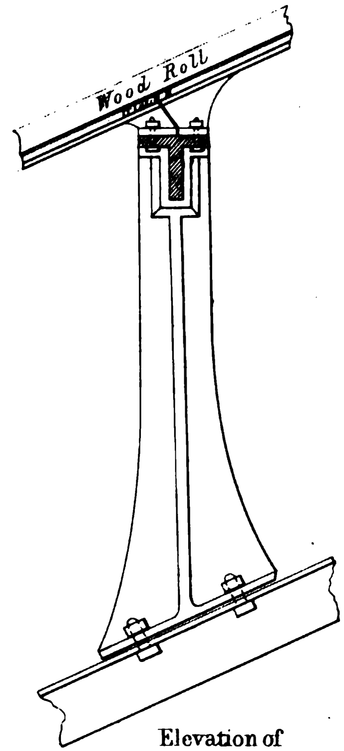
Details 1 inch to a foot



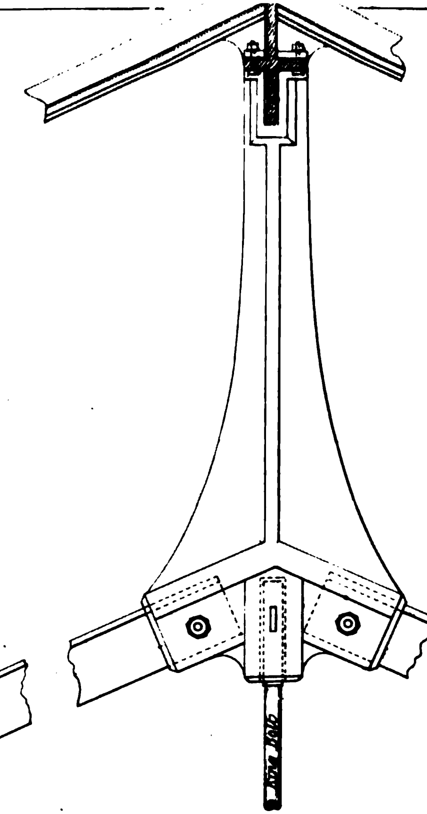

Section of Sash Bar with Wood Roll ⅓ full size.

Elevation of Upper End of Queen Bolt and Strut together with Louvre Standard & Section of Louvre Frame.

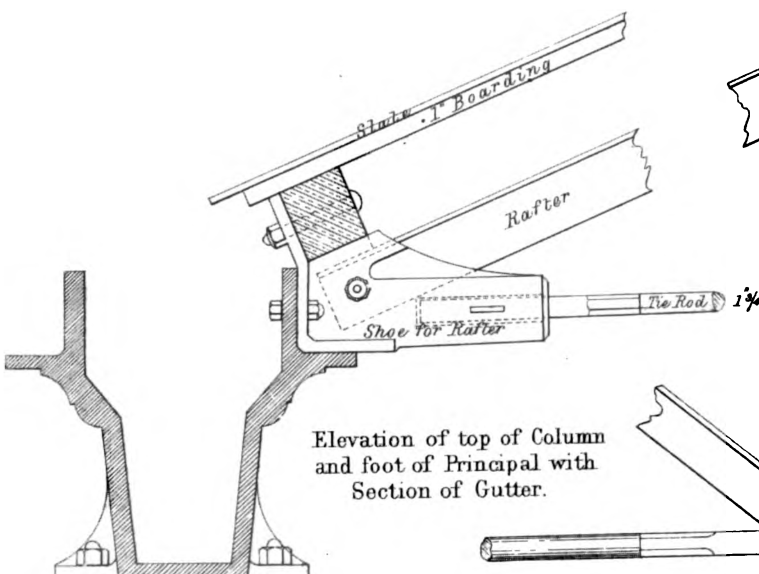


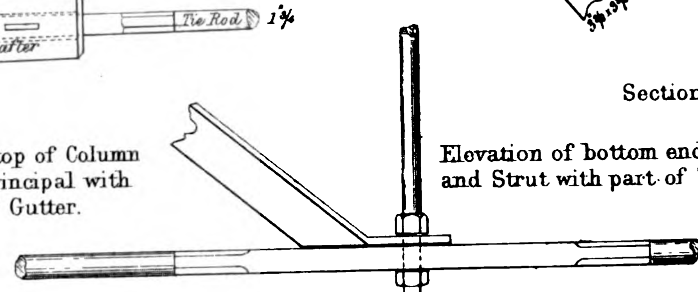

Elevation of Middle Standard for supporting Skylights.



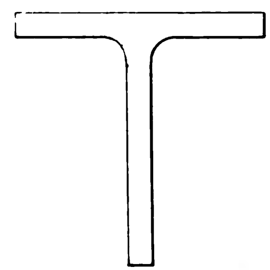

Elevation of Ridge Standard & King Head with Section of Ridge and shewing part of Glazing Bars.




Elevation of top of Column and foot of Principal with Section of Gutter.

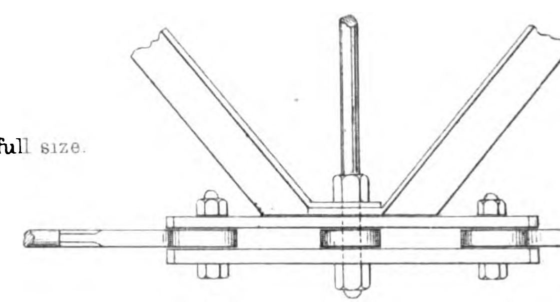


Elevation of bottom end of Queen Bolt and Strut with part of Tie Rod.



Section of Rafter ⅓ full size.

Elevation of King Bolt and Struts and part of Tie Rods & Connecting Links



## STANDING ORDERS OF PARLIAMENT.

During the present session, an important question is engaging considerable attention before the examiners of petitions for private bills in the House of Commons. This question relates to the deposit of plans and sections, where it is sought to continue or amend an act passed for making a railway. It is well known, that during the period which has been emphatically called that of the "Railway Mania," a great number of acts were passed, the powers of which have never been executed, and the consequence is, that about this time, the powers have either expired or are about to expire. In consequence of this numerous bills have been brought into Parliament, both in this and in the last session, to revive the powers of certain acts which have either expired or are about to expire, and hence the question has arisen,—whether new plans and sections are required for such bills? In order to make this question intelligible, it must be explained, that according to the Standing Orders of the House of Commons, all private bills are divided into two classes—the first class comprising those for which no plans and sections are required to be deposited, and also comprising bills for *continuing* or *amending* acts passed for any of the purposes included in this or the second class, where no further work than such as was authorised by a former act is proposed to be made. The second class includes all those bills for which plans and sections are required to be deposited, including railways, canals, roads, &c.

Now, in all railway acts, the powers for the compulsory purchase of land, and the power to make the railway, expire after a certain number of years; and there can be no doubt, if the act for continuation be introduced while the powers of the original act are still in force, the object being merely to extend those powers during a further term of years, such a bill would undoubtedly come under the first class, and no plans and sections would be required in respect of such bill. But the case is widely different when the powers of the original act have expired, for then the new bill can scarcely be called a bill for *continuing*, but really appears, to all intents and purposes, to be a new act intended to confer new and original powers.

The decisions of the two houses with respect to this intricate point are not yet complete, but as far as they have gone hitherto, the decisions are at variance with each other.

In the House of Commons, it was held last year by the examiners, that when powers for the compulsory purchase of land had expired, but when powers to make the line still existed, a bill of the first class might be brought in to amend and continue the original act. In the House of Lords, however, this decision was directly reversed in the case of one special and as well-known bill—that of the South Staffordshire Railway. In this case, when the powers of compulsory purchase had expired, but powers to make had not expired, the Lords' Committee held that the bill was of the second class, and actually rejected the bill because the plans and sections applicable to bills of that class had not been deposited. So far, the decisions of the two houses are entirely at variance; but during the present session there are several bills before the examiners in the House of Commons where *all* the powers of the original act have expired, and the parliamentary agents are endeavouring to force these through as bills of the first class, not requiring plans and sections. Whatever may be the fate of these bills in the House of Commons, the result which will follow in the House of Lords is sufficiently obvious, since the decision of the latter being directly opposite to that of the Commons when any part of the powers have expired, will be still more strongly opposed to allow the bill to rank of the first class when all the powers of the original act have expired.

Seeing that this remarkable difference exists at this moment between the views of the two Houses of Parliament, let us consider for a moment which view appears to be most reasonable and consistent with justice and common-sense.

The entire powers of an act generally expire in five years, and, on application to the Board of Trade, it is possible to obtain a certificate extending the duration of these powers for a further period of two years, making in all a term of seven years. Now, if it be conceded that these powers may be revived at any time within the seven years without the deposit of new plans and sections, surely this is sufficiently liberal, without giving a company powers to come at any time after the seven years for revival of powers.

Most persons at all conversant with surveys, and accustomed to compare plans with the ground, will admit, that even in a much less period than seven years the face of a country, especially in an improving agricultural district, or even in a town, may be very much altered,—often so much altered as to make the original plans worthless.

The least therefore that a company can do, after the expiration of the seven years, is to deposit new and correct plans and sections, showing the accurate configuration of the country at the time of making the deposit. Remarks of the same nature apply to the Book of Reference, which undoubtedly ought to be new, as it is well known that tenancies or occupations frequently alter to a very great extent in less than seven years.

In fact, if the principle which is now advocated in the House of Commons be carried out, there is nothing to prevent a company coming to parliament twenty and even a hundred years after the expiration of their powers, asking for a revival under the name of a continuation, and claiming to bring in their bill without depositing plans and sections, or complying with any of the forms applicable to bills of the second class. We often hear complaints of the injustice and annoyance inflicted by too rigid an adherence to the mere technical formalities of the Standing Orders, but here is a case where a strict carrying out of the Standing Orders is a necessary measure for the protection of the landowner and others interested in the country to be traversed by the railway.

It is a case where immense injustice would be done by dispensing with the necessary plans and sections; as no one could otherwise know how his land is to be affected, or what is intended by the railway company. While we hope earnestly, that the question, as one of practical importance, will be speedily settled by an agreement between the authorities of the two houses, we cannot doubt, that in the present instance the House of Lords is correct in its decision.

Since the preceding remarks were written, one of the examiners has decided, in the case of an act passed in 1846, when a bill is brought in during the present session to continue that act, the whole of the powers having expired, that plans and sections ought to have been deposited, and in consequence has declared that the Standing Orders have not been complied with. This decision will probably be confirmed by the Standing Orders Committee; and so far the practice of the House of Commons will be assimilated to that of the Lords. The only point of difference now remaining between the two houses will be in the case of bills where all the powers have not expired.

## ON THE ACTION OF SAILS AND RUDDERS.

At a meeting of the Royal Scottish Society of Arts, the Rev. J. Brodie gave the results of some inquiries he had made into the principles on which the action of sails and rudders depends. After showing the importance of distinguishing between the overturning and impelling influence of the wind, he gave, as the result of his calculations and observation, the following rule. The faster any vessel sails in proportion to the velocity of the wind, when the wind is on the side, the more acute should be the angle which the sail makes with the line of the vessel's motion, in order to produce the greatest impelling force; and, on the other hand, the slower the vessel's motion in proportion to that of the wind, the more obtuse should that angle be made, in order to prevent at once a diminution of the impelling force, and a dangerous increase of the overturning influence of the wind.

He then directed attention to the alteration which should be made on the position of the after-part of the sail, in consequence of the wind rebounding from the anterior portion of it, and showed that the effect of the air rebounding from the fore-part of the sail would require the general angle of inclination to the line of the vessel's motion to be more acute than it would otherwise have been, and that all fore and aft sails should be drawn as tight as the strength of the materials will permit. In regard to the action of rudders and other appliances for steering a vessel, he showed the different forces on which that action depends, and directed attention to the fact, that the action of a sail near the stern not only resembles that of the rudder, but, being independent of the vessel's motion, might in many cases be advantageously substituted for it; and suggested, that in tacking sharp-built vessels the mizen-sail should be brought round much further to windward than is usually done, in order to prevent them missing stays.

## ON THE FRENCH AND OTHER METHODS OF CONSTRUCTING IRON FLOORS.

By Mr. Barrett.

At a meeting of the Royal Institute of British Architects, on January 23rd, Mr. Barrett requested permission to read a Paper in continuation of that read by Mr. H. Burnell at the previous meeting (see *Journal*, *ante* p. 54), containing some further explanation of the system of fireproof construction with which he was connected, and which was known as "Fox and Barrett's Patent;" and stated that the objects accomplished by this system, whether applied to public buildings, dwellinghouses, warehouses, mills, or other structures, were as follows:—

To make each floor, as well as the roof of the building, fireproof, so that fire can neither be communicated from one story to another, nor be introduced into the building by burning away the roof;

To avoid all lateral thrust or weakening effect upon the walls, and to distribute the weight over them, instead of concentrating it on certain points;

To secure the building from the attacks of dry rot;

To give increased solidity, firmness, and durability to the structure;

To render the floors practically sound-proof, when finished with a boarded surface;

And to combine these advantages with great simplicity and economy of construction, and a much less thickness of floor than is usually required.

These objects are accomplished by forming the floors of the buildings of materials as imperishable as the walls themselves, the leading features of the system being, the substitution of girders and joists, either of wrought or cast iron, for those of timber, and the employment of layers of incombustible materials, supported by and consolidated with the joists; the whole, when combined, forming a solid fireproof foundation, adapted to receive a finished surface, either of cement, asphalte, tile, slate, stone, or other material; or upon which foundation the ordinary boarded surface, upon light sleepers or bevilled fillets may be laid down.

The principle of construction, as applied in its most simple form, is shown in drawing No. 1.* The joists are fixed as the building proceeds, the ends being firmly built into the walls; and the floor is afterwards formed by light strips of wood, being first laid across from joist to joist, bearing on the bottom flange, and having narrow spaces between them. Upon these is spread a layer of coarse mortar, which is pressed down between the strips, so as to form with them a rough and uneven surface for the pricking-up coat of the ceiling; the subsequent application of which thoroughly imbeds the strips in mortar. A layer of concrete is then applied, of the requisite thickness to ensure the necessary rigidity in the floors. This thickness is determined by the nature of the building, the width of bearing, and the required degree of strength. The ceiling is applied of such a thickness as to perfectly imbed the flanges of the joists, and thus protect them from the action of fire from below. A fireproof foundation is thus formed, which, when thoroughly consolidated by the perfect setting of the concrete, is of great strength and rigidity, while the pressure upon the walls is *strictly vertical*. The finished surface of the floor is applied when the concrete is set and dry.

The joists are made of a form combining strength, lightness, and economy; their section depends upon the nature and uses of the building to which they are to be applied, and in all cases they are proved, before they are fixed, to an extent more than equal to the greatest load that can ever be brought upon them, care being taken that this proof is within one-third of the breaking weight in the use of cast-iron, and within the elastic limit of the material in the use of wrought-iron. This precaution may perhaps be considered unnecessary with the latter material, more especially as the mode of construction is one which, in effect, ties the whole of the ironwork together. It is, however, more satisfactory to prove the joists, and it is done with a lever at the most trifling cost.

The strips, which answer the double purpose of a foundation for the concrete and a key for the ceiling, may be made of any non-combustible material instead of wood; but it will be seen that these strips are so placed that their ignition is impossible, as they are completely imbedded in the mortar, and have a superincumbent mass of concrete, which prevents the establishment of any current of air, and renders them practically proof against fire. This has been proved on several occasions. Amongst other materials that can be substituted for these wood strips, small draining pipes may be mentioned, and if made of a triangular form they give an excellent key for the ceiling.

The concrete is formed of the materials most readily obtained in the locality of the building, such as fine gravel or ballast, burnt clay, or broken brick, mixed with a proper proportion of good stone lime, the whole being laid on moist, and well trodden in.

For the finished surface of floor, besides the ordinary flooring-boards, cements of different kinds, such as Portland, Keene's, and Parian, may be used. Asphalte, metallic lava, slates, and tiles in cement have also been employed as a finished surface, both for floors and roofs.

In applying this system to dwellinghouses and similar buildings, the joists are first tested singly to bear weights equal to from 120 lb. to 150 lb. per square foot of floor; that test being in the case of the employment of cast-iron one-third of the breaking weight, and in the case of wrought or rolled iron, the elastic limit of the metal. For buildings of a different character, and requiring stronger floors, the strength and the test are increased so as to meet the requirements of the structure. The joists are then fixed on the walls, and when built upon they form a series of ties, which greatly strengthen the building. A considerable accession of strength is given to the joists by their ends being thus firmly fixed in the walls, and every successive step in the process of construction tends both to develope additional strength, and also to protect the joists from the effect of impact or concussion. The strips or pipes are the groundwork of a continuous strut, which is completed by the subsequent application of the mortar and concrete, the latter completely imbedding the whole of the ironwork, which is pressed equally on both sides, and the concrete well trodden under the upper flanges of the joists. Thus it will be seen that the force of compression acts upon the joists only through the medium of the concrete. What the actual addition is to the original strength of the joists by, in the first place, firmly fixing the ends, and then by the perfect union and combination obtained in the process of construction, has not been ascertained; but an idea of the enormous weight that would be required to break down a floor may be thus obtained:—Supposing the room to be 18 feet square, thus containing 324 feet in area; the joists, having an original working strength of 120 lb. to 150 lb. per foot, the *average ultimate* strength is 405 lb. per foot, and if it is assumed that an increase of 25 per cent. only is obtained by the fixing and the consolidation of the entire mass, the breaking weight is 500 lb. per square foot, which, multiplied by the number of feet (324), gives 1446 *cwt.*, or upwards of 72 *tons*, as the load required to break down the floor of a room 18 feet square; and this, it should be remembered, is not a floor in which extra strength is provided, but merely the room of an ordinary dwellinghouse, which if packed with 200 people, or as full as the "Black Hole" at Calcutta, would only be loaded with 15 *tons*, or about one-fifth of the breaking weight of the floor. In assuming 25 per cent. as the gain in strength, a low estimate is taken, for an increase of twice this, or 50 per cent. is commonly reckoned as due to the firmly fixing of a beam alone; while the great principle of this system is the gradual development of strength and firmness; the effect of the load being transferred, through the medium of the concrete, to the walls or other vertical supports; the entire floor becoming in effect *one large beam with iron ribs*. This calculation has reference to the use of joists of cast-iron; with joists of wrought or rolled iron the ultimate strength would be considerably greater.

There is of course a limit to which single joists can be carried on this system, but as rooms 24 feet in width have been constructed with them, and without the use of main girders, it is very rarely that the latter are required for dwellinghouses and buildings of the same class. When, however, the span much exceeds 20 feet, the adoption of girders with minor joists bearing upon their flanges is the most economical method. In this way, floors of 60 feet span have been constructed, the girders having an intermediate bearing on columns placed 20 feet apart. Floors of 30 feet, 36 feet, and 42 feet span have also been constructed with girders and joists, without the aid of columns.

It may be said therefore that there is scarcely a limit to the application of the system as regards the space to be covered,

* The drawings referred to were exhibited at the meeting, but we are unable to publish them in our present Number: the discussion on the subject being again adjourned, we hope, however, to be enabled to illustrate the various systems referred to by Mr. Barrett, in our report of the discussion next month.

while there is probably no kind of building to which it is not capable of being adapted. Besides public buildings of different kinds, such as hospitals, lunatic asylums, and workhouses; buildings for records, railway offices, banks, hotels, exhibition-rooms, baths and wash-houses, training institutions and schools, &c., the system has been extensively adopted in private buildings, such as mansions, dwellinghouses, offices and chambers, and dwellings for the working classes. It has also been employed in the construction of warehouses and mills.

This system of construction is not therefore to be regarded as a mere theory, but as one which has been very extensively applied, and has moreover stood the test of an experience of twenty years: I mention this first to disclaim all merit whatever in having originated it. It is to a member of the medical profession, recently deceased, Dr. Henry Hawes Fox, that we owe the introduction of this principle of construction. That gentleman erected, in the years 1833-4, an extensive private lunatic asylum in Gloucestershire, and built it entirely upon this principle, and ten years afterwards, in the year 1844, at the urgent solicitation of his friends, and as the only means of bringing a valuable invention, which had on several occasions saved the building from destruction by fire, into general use, he was induced to patent it. My own connection with it dates from the year 1848, since which period it has, as I have said, been applied successfully to almost every description of building. Another reason for my mentioning the early employment of this mode of construction, and the date and object of its being patented in England, is, that it has struck me that some persons may possibly imagine that the principle may have been borrowed from the French system, described in Mr. Burnell's paper. Nothing could be more erroneous than such a supposition; a comparison of dates, indeed, at once sets this question at rest, the patent having been taken out in 1844, ten years after its successful employment by the patentee, while, as I gather from Mr. Burnell's paper, the employment of the French system is comparatively of recent date.

In 1850, I visited Paris myself, with letters of introduction to various architects, only one of whom referred to the use of iron there. He told me that a building was then in course of erection, and recommended me to see it, which I did: it was the Hospice de la Republique, near the Northern Railway Station. The floors were formed by means of girders of wrought-iron, consisting of two rectangular bars, the lower one straight, and the upper one arched or curved, both placed on edge, and the two occasionally tied together by vertical straps. These were placed about 5 feet apart; cross-bars 5 feet apart were carried at right angles with the girders, and three smaller flat bars on edge ran between each girder: spaces of about 4 feet × 15 inches were thus formed, and these spaces were filled in with pottery, slightly wedge-shaped, imbedded in plaster; dwarf walls were built on the top of the pots to receive timber-joists, upon which the floor-boards were laid. The whole appeared to be a very expensive mode of construction, occupying a depth of about 18 inches for a span of 3½ mètres, or 11 ft. 6 in. This was the only instance I heard of, at a period six years subsequent to the date of the patent. But independently of priority of date, it will be seen on close examination that the two systems differ both structurally and economically, the only point of resemblance being the form of the joists, which are alike, except that the French joist is made to taper towards the centre or neutral axis. The peculiar form of intertie adopted in Paris is available where plaster is abundant, the chemical constituents of this material enabling it to set so rapidly that a considerable open space can be filled in without any intervening support. These interties however are necessarily much more expensive than the strips upon which the concrete is laid in my system, and which are the mere refuse of a builder's yard. The material used for filling-in is different, both as regards its thickness, its tendency to expand, its possible effect on the iron, and the strong affinity of gypsum for ammonia; and the final results of the two modes of construction are different,—the one producing a finished floor, admitted to be subject to deflection with an ordinary load, and the other producing a floor of very great rigidity.

In illustration of the method of applying this system in cases of extended bearings, where the use of girders is necessary, the drawings Nos. 2 and 3 and from 7 to 11 are exhibited. No. 2 is a section illustrating the application of the system with both girders and joists of cast-iron, and shows the method of construction employed at a large flax mill at Newry, the plan of one floor of which is given in No. 3, an Ironmongery Warehouse at Bristol, St. Mark's College, Chelsea, the Metropolitan Convalescent Asylum, and various other public and private buildings. The girders, a section of which is shown, bear either upon columns or walls, and the joists, which are shown in elevation, run at right angles to the girders, and are cast with a shoulder to drop over the flange of the girder, and form a tie. The depth of the girders is of course in all cases adapted to the span, and when this depth is greater than the thickness of the floor, an intermediate flange, supported by side feathers, is cast upon the girder. The projection below the ceiling line should be covered either with plaster or fireproof cement, and take the form of a moulded beam, as shown in the figure, drawing No. 2. The thickness of the floor in this construction rarely exceeds 10 or 12 inches, and the saving of space as compared with the iron girder and brick arch system, will be understood from the fact that a depth of 20 inches is required at the springing line of the arches. This difference, in a mill or warehouse several stories in height, will either economise 3 or 4 feet of walling all round the building or give an increased height in the different floors. Drawing No. 7 shows the combination of wrought-iron boiler-plate girders and cast-iron joists, as adopted at the recently erected extensive additions to Guy's Hospital, where the rooms are from 21 feet to 30 feet wide. The main girders have cast brackets riveted to the web to receive the joists, which are of cast-iron with shouldered ends, to drop into the brackets: considerably more than an acre of floor has already been so constructed in this building. Drawing No. 8 shows the application of wrought-iron exclusively; both girders and joists being of this material. The girders, which are also of boiler-plate, have an additional or intermediate flange of angle-iron, to give the requisite bearing for the joists; which latter are of rolled iron, and are occasionally tied to the girders by small angle-plates, bolted or riveted on. This application of the principle has been adopted in various public buildings (amongst which may be mentioned, the Foundling and Brompton Hospitals, the New Offices of the London and Brighton and the Bristol and Exeter Railway Companies, Her Majesty's New Highland Residence, Balmoral, &c.), 42 feet being the extreme width of bearing to which it has been at present carried; but there is no difficulty in extending it much beyond this, as the adaptation of boiler-plate girders to this system of construction, combined with joists of rolled iron, provides for every possible contingency, whether as regards width of bearing, strength of floors, or liability to impact or vibration. In cases, however, where the use of columns can be admitted to shorten the bearings to 9 or 10 feet, the same advantages may be secured by the adoption of rolled iron, for both girders and joists, thus avoiding the use of riveted plate and angle-iron girders, the labour on which necessarily makes them somewhat expensive. Diagrams illustrating this double application of rolled iron are shown, drawing No. 9 being the plan of a floor 63 × 28 feet, with a row of cast-iron columns running down the centre: these columns support a line of rolled iron girders, which pass through a hole left in the top of the column, as in drawings Nos. 10 and 11. The joists are carried over the backs of the girders, and are rolled of a length to span the full width of the building, including the bearing on each of the side walls. The advantage of having the joists rolled in long lengths, and fixed with an intermediate support on the main girders, is a most important one, not only as affording an efficient tie to the building, but as greatly increasing the strength of the floor; this is an advantage which is peculiar to the use of wrought-iron. The ends of the joists may be either pierced and secured to the walls by a rod or S piece, or they may be bolted to a plate of iron built into the wall. The extreme ends of the girders being also secured to the walls, a tie in each direction is given, and the whole forms a framework of wrought-iron, possessing immense strength, each part affording efficient aid to the rest. In buildings of greater width, the addition of another line of columns would enable the same arrangement to be adopted; the joists being in that case rolled in long and short lengths, placed alternately so as to break joint, and bolted or riveted together at the points where they take a bearing on the girders.

I have already remarked, at the former Meeting, that from prejudice against cast-iron joists, though they have been very extensively and successfully used, I was induced three or four years ago to turn my attention to wrought-iron. But here I had to break entirely new ground, to institute experiments, and to overcome many obstacles from the manufacturers. The main question was as to sufficiency of strength in a section of a form best adapted for the purpose—the ═ shape—but for the manufacture of which no rolls were in existence. Experiments were therefore tried on ⊥ shaped bars, and a formula deduced from these, and acted upon by my having rolls prepared from 4 to 8 inches deep of the ═ section. Subsequent experiments on these had fully verified the correctness of the formula, but I had not carried my experiments more than 60 per cent. beyond the limit of elasticity, this amount of strain producing a permanent set of only $\frac{3}{40}$-inch. I had heard that iron joists were coming into use in France, but knew nothing of the strength they employed, and have never seen either the joists or floors to this day. I have however recently obtained some information as to the strength considered sufficient in Paris: a friend who is about to build there had sent me some particulars obtained from the engineer of the company manufacturing the joists, and a printed statement of experiments on their strength. This information and these experiments are important as bearing on the question of cost, to which I will almost immediately refer. It seems that under no circumstances, and except in a very extraordinary case, would they place the joists less than from 70 to 80 centimètres apart; and for a floor of 6 mètres, joists 12 centimètres deep, and weighing 14 or 15 kilogrammes per mètre, would be used.

I think the first point to establish is the sufficiency, or rather the actual strength, of the joists, of the scantling used in Paris, and the table of experiments enables us to examine this:—

Joists of 12 centimètres deep, and weighing 15 kilogrammes per mètre, were proved at bearings of 4, 6, 8 and 10 mètres. Converting these into English dimensions, we have for the bearing of 6 mètres, 19 ft. 8¼ in.; for the depth of the joists, 4¾ inches; for the weight per feet run, 10 lb; and for the mean distance apart, 75 centimètres, or 30 inches. From the table I find that a joist of these dimensions was proved at 6 mètres bearing with 2000 kilogrammes on centre, which is equal to 4000 distributed, or 8800 lb. English. The area of floor this joist would carry is—

19′ 8″ × 2′ 6″ = 49′ 2″ and 8800 lb. ÷ 49′ 2″ = 179 lb. per foot super.

But a similar joist was proved with the same weight at 8 mètres bearing, which is equal to 5333 kilogrammes at 6 mètres:

5333 kilog. = 11730 lb. English ÷ 49′ 2″ = 240 lb. per foot super.

But even this did not reach its limit of ultimate strength, for the joist was further tested at 10 mètres bearing, until the deflection was increased to the extent of just 50 per cent. beyond the last load. It may therefore be safely assumed, that a load of 300 lb. per square foot of floor, would not have broken the joist.

None of the joists I use have been tested to anything like this extent, for as I have said, I have proceeded upon the principle that the joists should not be loaded beyond their elastic limit. We however easily arrive at the strength of such a joist as I have been referring to (for the purpose of comparison) by adopting the simple and universally received formula, that the strength is as the depth$^2$ × thickness, and I will reduce both this joist and the one I have used (and which forms the basis of my calculations of comparative cost with a timber floor) to rectangular bars, and compare them:

Taking first the French joist—a weight of 10 lb. per foot gives a sectional area of just 3 square inches; and a rectangular bar of this area and 4¾ inches deep, would give the following result:—

15 kilog. per mètre = 10 lb. per ft. = 3 sq. in. = $4{\cdot}75^2 \times {\cdot}63 = 14{\cdot}214$
while the English joist = 16 lb. ,, = 4·8 ,, = $7^2 \times {\cdot}686 = 33{\cdot}614$

And further,—

$$14{\cdot}214 \div \overline{19'\,8'' \times 30''} = {\cdot}289 \text{ per square foot,}$$
$$\text{and } 33{\cdot}614 \div 20'\,0'' \times 24'' = {\cdot}840 \quad ,,$$

Giving the result of a comparison of strength just 1 to 3; while a comparison of weight would stand thus:

French joist carries 19′ 8″ × 30″ = 49′ 2″ weighing 220 lb. = 450 lb. per sq.
English joist carries 20′ 0″ × 24″ = 40′ 0″ ,, 352 lb. = 880 lb. ,,

This gives a result of very nearly as 1 to 2.

Now the conclusion seems unavoidable, that if, as I have demonstrated, the breaking load of the French scantling of joist is equal to 300 lb. per square foot, it is in my case equal to 900 lb. per square foot; but even this is assuming that no strength whatever is derived from the principle of construction, while I believe that with properly constructed floors, that is, with good concrete of the proper thickness, these results, satisfactory as they are, may be increased by at least 50 per cent.

Turning now to the question of cost, the following statement has been prepared of the approximate comparative cost of a floor for a room 12 feet square, and for one 20 feet square, constructed on the fireproof principle, and with timber. The results are as follows:

| | Room 12′ × 12′ £ s. d. | Room 20′ × 20′ £ s. d. |
|---|---|---|
| Fireproof floor, formed with strong joists of rolled iron, and a cement surface | 7 14 10 | 32 4 3 |
| Deduct excess of iron in joists to reduce them to the strength of the French scantling | 1 17 10 | 10 12 1 |
| Cost of fireproof floor | 5 17 0 | 21 12 2 |
| Add difference of cost between 1 inch flooring boards and a cement surface 25s. per square | 1 16 0 | 5 0 0 |
| Cost of fireproof floor with boarded surface | 7 13 0 | 26 12 2 |
| Cost of timber floor pugged | 8 15 4 | 31 12 3 |

These calculations are made with the price of iron nearly 50 per cent. above that of eighteen months ago, and much dearer than for many years past. The details of these calculations are given below:—

*Dimensions of Room,* 12 × 12 *Feet.*

*Fireproof floor formed with strong joists of rolled iron and cement surface—*

| | | |
|---|---|---|
| Five rolled joists, 13′ 8″ long, 8¼ lb. per foot—113 lb. each —5 cwt. 5 lb. @ 15s. | 3 15 8 | |
| Concrete, &c., ceiling and cement surface of floor, 55s. per square | 3 19 2 | |
| | £7 14 10 | |
| Deduct excess of iron in joists to reduce them to the strength of the French scantlings, £3 15s. 8d. ÷ 2 | 1 17 10 | |
| Cost of fireproof floor | ...... | 5 17 0 |
| Add difference of cost between 1 inch flooring boards and a cement surface, 25s. per square | ...... | 1 16 0 |
| Cost of fireproof floor with boarded surface | ...... | £7 13 0 |

*Timber Floor—*

| | | |
|---|---|---|
| 11 joists, 13′ 6″ long, 9″ × 2″ = 18¼ cubic feet @ 3s. | 2 15 6 | |
| Wall plates, 24 feet run, 4½″ × 3″ = 2¼ | 0 6 9 | |
| Herring-bone strutting, 3s. per square | 0 4 6 | |
| Half-brick trimmer and centering, 4′ 0″ × 2′ 0″ | 0 8 0 | |
| 144 feet sup. 1 inch flooring boards, @ 35s. per square | 2 10 5 | |
| 16 yards lath and plaster ceiling, @ 1s. 4d. | 1 1 4 | |
| 144 feet sup. fillets, sound boarding and pugging, @ 20s. per square | 1 8 10 | |
| Cost of timber floor, pugged | ...... | £8 15 4 |

*Dimensions of Room,* 20 × 20 *Feet.*

*Fireproof floor formed with strong joists of rolled iron and cement surface—*

| | | |
|---|---|---|
| Nine rolled joists, 22′ 0″ long, 16 lb. per foot—352 lb. each—28 cwt. 1 qr. 4 lb. @ 15s. | 21 4 3 | |
| Concrete, &c.—ceiling and cement surface of floor, 55s. per square | 11 0 0 | |
| | £32 4 3 | |
| Deduct excess of iron in joists to reduce them to the strength of the French scantlings, £21 4s. 3d. ÷ 2 | 10 12 1 | |
| Cost of fireproof floor | ...... | 21 12 2 |
| Add difference of cost between 1 inch flooring boards and a cement surface, 25s. per square | ...... | 5 0 0 |
| Cost of fireproof floor with boarded surface | ...... | £26 12 2 |

*Timber Floor and Ceiling of a substantial kind—*

| | | |
|---|---|---|
| 17 joists, 22′ 0″ long, 12″ × 2¾″ = 85⅔ feet cube, @ 3s. | 12 17 3 | |
| Wall plates, 40 feet run, 4½″ × 3″ = 3¾ | 0 11 3 | |
| 2 wrought-iron ties, ¾″ diameter with screws, &c., 40 feet @ 7½d. | 1 5 0 | |
| Herring-bone strutting, 3s. per square | 0 12 0 | |
| Half-brick trimmer and centering, 6′ 0″ × 2′ 0″ @ 1s. | 0 12 0 | |
| 4 squares 1¼″ battens, @ 42s. per square | 8 8 0 | |
| 44½ yards lath and plaster ceiling, @ 1s. 6d. | 3 6 9 | |
| 4 squares fillets, sound boarding and pugging, @ 20s. | 4 0 0 | |
| Cost of timber floor, pugged | ...... | £31 12 3 |

Mr. Barrett stated, in reference to the practicability of reducing the scantlings of the joists on his principle, that although it might not be desirable to reduce them to the French standard, he had no doubt rolled iron joists of an intermediate strength between those used in Paris and his own, might be employed with safety, and thus bring down the cost of a fireproof floor with a boarded surface to that of an ordinary pugged timber floor. M. Thomas, an eminent Parisian builder, had adopted Fox and Barrett's principle in several houses in Paris, using joists of the strength generally employed there, and he had found the floors superior to the French system, which was defective from its want of rigidity, and from allowing the transmission of sound when the hollow pots were used in combination with the plaster. Mr. Barrett concluded by observing, that it might be considered that he had a personal interest in advocating the English system. Undoubtedly as the proprietor of the patent, to a certain extent he had; but his interest in the patent was for a limited period,—

a period which would be totally inadequate to repay even one-half of the very large sum which had been sunk in establishing it. Independently of personal considerations however, the subject was one of general interest; and as the losses by fire in this country were reckoned by millions of pounds annually, he might say it was one of national interest. Certainly, the general introduction of a system which must promote the use of iron (a material for the production of which our resources were unlimited, and in the manufacture of which native skill only was employed) should be encouraged in every possible way.

*Discussion.*—Mr. MOCATTA (the Chairman) said, that as architects they must feel the importance and advantage of an incombustible and imperishable floor. With reference to cost, it appeared desirable to ascertain the degree of lightness which would be free from vibration and deflection, in order to avoid a very expensive mode of construction. Mr. Barrett's system was, he believed, the development of that executed some years ago in Gloucestershire by Dr. Fox, which excited much interest at the time. With respect to one matter of detail in Mr. Barrett's system,—namely, the small laths placed between the joists to receive the concrete, he inquired whether those laths were not very slight to carry so great a weight, as if they were liable to become bent, the consequence would probably be a cracked ceiling.

Mr. BARRETT stated that these laths were merely used as a support to the concrete, till it became set. They were 1 inch square by 24 inches long, between the bearings on the iron joists; the weight upon them being only $\frac{1}{16}$th of their breaking weight. As the concrete became set, the structure became wholly independent of these strips, and if it were practicable to remove them, the structure would for any purposes of strength be complete without them. He had constructed many acres of flooring in this way, and not the slightest difficulty had arisen from the cause suggested.

Mr. TITE, said, it appeared to him that the present question was a little involved in a discussion raised some time ago by the late Professor Cowper, who had brought before the Institute the wonderful merits of construction adopted in the Crystal Palace, and told them that they were behind hand in all inventions, and had to learn everything from the engineers, especially the use of iron. Now he, Mr. Tite, freely admitted the ingenious application of familiar principles which the French system of flooring displayed; but the question of cost, referred to by the Chairman, was probably the main reason why iron joists of this character had not been more extensively used. Architects had certainly been taught by the engineers to be more extravagant than they used to be, but to an architect the question of cost must be one of the gravest consideration. It was true that in Paris they had seen a great deal of the application of wrought-iron joists by Visconti and others, but he felt bound to claim a perfect acquaintance with this matter in his own experience of some twenty-eight years. There was, in fact, nothing new in the principle, either as respected the iron or the concrete. Mr. Tite then adverted to the early methods of forming floors: first by a row of beams placed side by side, the least dimensions downwards, and of an uniform substance, and afterwards by means of strong heavy girders or bearing beams of oak, producing the greatest possible rigidity. This system, introduced in Italy, was adopted by Sir C. Wren, and when (after the fire of London) oak became scarce, fir was used in the same way. This however, being more elastic, was found to bend, and a system of trussing girders by the insertion of iron was adopted, and gradually carried to a great extent. (Mr. Tite described, and illustrated by sketching, several of the varieties of trussed girders formerly in use). Sir Robert (then Mr.) Smirke at length introduced the cast-iron girder, and the use of concrete (the latter in the foundations of the Penitentiary, which had failed). Feeling the defects of the old systems of flooring, and believing that they might be remedied by the employment of cast-iron girders, Sir R. Smirke, after consulting Mr. John Rennie, introduced the use of them, and had told him (Mr. Tite) that the first he used was of the extraordinary length of 34 feet, without a support between the walls. The next step was made by Mr. Farrell, a smith, who was employed under Sir R. Smirke at the Custom House, and he, regarding cast-iron as a very brittle and dangerous material, proposed the use of wrought-iron, for which he took out a patent; and between that system of Mr. Farrell's, and the systems now under discussion, there was in fact no difference whatever, except in the ingenuity of the means which had been brought to bear upon the latter. In France earthern pots or plaster were used with iron rods between the joists, in England concrete and wooden laths; but these were merely improvements on the patent of Mr. Farrell, who suggested that the space between the joists might be filled in with any fireproof material. The joist adopted by him was of this form ⊥, and as he could not get rolled iron, he riveted the parts together. Mr. Tite stated, that he had used the system described, many years ago in a large public school, where a cheap fireproof floor was required, with complete success, and when he last saw this construction it was as perfect as when first erected. The space between the joists was in this case about 4 feet and filled in with 4 inch and 6 inch Yorkshire landing; which gave a good upper as well as under surface, the interstices being filled with Roman cement, and the ceiling formed of the same material. This was applied to a space of 300 feet long, and on an average 15 feet wide. Important as this subject was, Mr. Tite proceeded to express his opinion, that the systems of flooring referred to were not applicable to architecture in its more important forms. They might do for a range of offices, an hospital, or any building where plain ceilings were sufficient; but the architect had to consider decoration, and must apply his means accordingly; and it would often happen that the ordinary mode of construction introduced by Sir R. Smirke, with subsequent improvements, was better adapted to such purposes, than novelties of more recent invention. With regard to fireproofing, the world was not satisfied with actual safety, but required that no part of a building should be combustible, even if no danger could arise from its becoming ignited. Thus, at the Royal Exchange, where he had employed cast-iron girders, with arches in cement, the improper substitution of a new stove for the one fixed by his directions, had caused fire to communicate to the frame of a blank window. This frame however might have been entirely consumed without the slightest injury to the building, but the public was not satisfied: an inquest was held as to the cause of the fire, and great complaints were made that the building was not incombustible in every part. With regard to the safety in the use of concrete, as a protection from fire, especially when the concrete was only a few inches in thickness, Mr. Tite expressed much doubt, considering it inferior to the York landings employed by himself as above mentioned. Mr. Farrell had sent to Sir R. Smirke a description with drawings of his method, and the reply of Sir Robert was that he had done the same thing himself for twenty years, only turning the girder with the flange upwards T, instead of downwards. Whether Sir Robert had done this in cast or in wrought iron however, and to what extent, did not appear. He, Mr. Tite, should have used wrought-iron joists upon Mr. Farrell's plan more generally, but for the improvements and popularity of cast-iron girders; and should certainly have employed iron much more extensively, but for the great question of expense. He was very glad the subject had been discussed, as it would be of the greatest possible advantage, if a cheap and durable floor could be constructed, which should be fireproof in the honest sense of the word.

Mr. T. H. WYATT considered that the present was not a question of precedency, but of general applicability; and as he had been one of the first to use Messrs. Fox and Barrett's system extensively, and had employed it to the extent of 1400 or 1500 squares, he begged to say a few words in its favour. In the Wiltshire Lunatic Asylum, erected by him, it was essential that the estimates should not be exceeded. Originally a judicious system of pugging had been contemplated, but by the adoption of Fox and Barrett's system, not one shilling had been added to the cost, and the results had been most satisfactory. He had tested the deflection of the joists employed, and found it very slight indeed; and he was convinced that any sound wall would bear the weight of this construction, amounting as it did to not more than 78 lb. for each superficial foot of flooring. Mr. Wyatt confirmed the experience of Mr. Piper as to any needless doubts which might be felt respecting safety of the construction until rigidity was imparted to it by the concrete filling in. This desirable result however was obtained in a most remarkable degree. In the building referred to, he had used joists up to 16 feet bearing, but others of larger bearings since employed had been equally satisfactory. He had felt some misgivings as to the possible decay of the wooden strips resting upon the joists, but he believed that, as Mr. Barrett stated, they might with safety be removed as soon as the concrete had set. The only serious doubt was, as to the action of any damp which might arise from the concrete, supposing the wooden floor to be laid covering it before it had had time to become thoroughly dry. He had used a boarded surface of floor with this system, though if he were building a house for himself, he would prefer one of cement. There were, he believed, no wooden floors in the asylum built by Dr. Fox. With respect to the depth of the iron joists, he had examined Mr. Barrett's calculations, and was convinced they were free from all possible risk, and might be made from a considerably reduced formula, and yet be within the mark of safety. Mr. Wyatt then adverted to the action of a body of flame upon ordinary plaster, and described some experiments made by Mr. Hardwick at the St. Katherine's Docks, in which plaster slabs 1⅛ inch to 1¼ inch thick, screwed to the underside of the wooden joists, were exposed to violent flames from tar barrels, and showed that very little fear need be entertained of the effect of fire upon a ceiling, even if the whole contents of the room were to become ignited. From this he inferred that the laths employed in Fox and Barrett's system did not constitute any objection to it; and he added that he considered it one which was really well deserving the attention of the members of the Institute.

Mr. I'Anson also spoke in favour of Fox and Barrett's system, and considered that although both that and the French system might have some analogy to the old methods described by Mr. Tite, they showed a great advance upon those methods. The concrete and other substances were superior to York landing, inasmuch as they tightened up the joists, and gave its chief value to the construction. The elasticity of the joists, until they were filled in was most remarkable, but in about six or eight months after completion the floor became perfectly rigid. He had employed Mr. Barrett's system in a large dwellinghouse 45 feet by 26 feet in dimensions, and the cost of iron did not exceed 90*l.*; the whole of the timber being saved.

Mr. Tite explained that the York stone in Mr. Farrell's plan was perfectly connected with the iron by means of the cement.

Mr. Boulnois stated, that it had been asserted by Mr. Brunel, that the concrete was very liable to become disintegrated, and so to part from the joists in Fox and Barrett's system, and to leave them hanging up like so many laths. He had used the system for a 19 feet bearing three years ago, employing joists without any upper flange, but the floor was subject to considerable vibration, which might be increased beyond the control of the architect—for instance, if used for dancing. He wished to know if the concrete formed a rigid slab equivalent to the stone employed by Mr. Tite, and whether in Mr. Barrett's experience, he had ever found the concrete shaken off from the joists.

Mr. Barrett said that he had not. The concrete could not be acted upon from below, nor from above except by a complete disruption of the upper part. He considered that Mr. Boulnois was altogether begging the question, by assuming the fact of vibration, which he could not allow to be taken for granted. After an experience of twenty years with bearings of as much as 18 feet, subject to all the ordinary wear and tear of a dwelling-house, he could not conceive the possibility of such a result as the concrete becoming loose.

Mr. Boulnois could confirm Mr. Barrett's opinion by his knowledge of the floor at Messrs. Nurse's coach factory, in Regent-street. There was a sag in that floor, in consequence either of the joists not being cambered, or not being supported in the middle; but that sagging had never increased, although the floor was subject to very great vibration from carriages being moved over it, nor had the concrete been disintegrated. These, however, were matters which patentees ought to be able to speak to, without leaving architects to find them out.

Mr. Barrett said that he had no means of finding out such a fact, which was not necessarily correct simply because Mr. Brunel had asserted its possibility. He must be content with referring to his own experience, confirmed as that had been by Mr. Boulnois himself.

Mr. Tite called attention to the question of Mr. Boulnois as to the degree of strength and rigidity of the concrete taken alone; and objection to a wooden floor over the concrete on the score of expense.

Mr. Piper said that his own gateway was covered with rolled iron joists, filled in with common York paving, and then (to meet the requirements of the old Building Act) covered with concrete, so as to make a thickness of 14 inches. He had, however, ceased to use this method, observing that York paving was exceedingly destructible by fire, and that practically it did not furnish a fireproof floor. With reference to the doubt suggested by Mr. Boulnois, he believed the patent floors would be found to move altogether, if at all; that there was in fact a close union between the concrete and the metal, and no distinction in the amount of vibration of each. A floor over a stable, subject to all the wear of a loft and granary, had stood for six years (covered with Portland cement) without the slightest disintegration. Mr. Piper concurred with previous speakers as to the resistance of plaster to the action of fire, and therefore considered the laths used by Mr. Barrett were perfectly safe.

Mr. Tite inquired what experience there had been of the action of fire on concrete. He apprehended if there were flint stones in it the concrete would split, and yield under the action of fire.

Mr. White referred to the fire at Mr. Ald. Humphrey's warehouses, in February 1851, where, he believed, the concrete alone prevented the spread of fire to the vaults, which were filled with valuable and combustible goods.

Mr. Barrett read an extract from the *Times* newspaper of the 21st February, 1851, in confirmation of this statement. He added that several fires had occurred in the building erected by Dr. Fox. On one occasion all the furniture in a room, and on another occasion a four-post bedstead and furniture, had been reduced to ashes without injury to the ceilings. Mr. Piper could probably explain the circumstances attending the fire at Messrs. Collard's manufactory at Camden-town.

Mr. Piper said, that there the upper floors were on iron girders, but not fireproof. The basement was covered with a light ceiling on Fox and Barrett's patent, and with ordinary care on the part of the firemen it would have preserved the property below. The firemen, however would not interfere, and what was termed a second fire took place, and destroyed the contents of the basement story.

Mr. Barrett read the official report of Mr. Baker, the district surveyor, to the official referees, describing in detail the circumstances referred to, and which concluded thus:—"From the foregoing statement, there is no reason whatever to doubt the efficiency of Fox and Barrett's patent, when applied as a sound fireproof party structure; on the contrary, I am well pleased with it, and even with its resistance to very great concussion, when the latter is spread over a surface; I only wish it had resisted the single and more *pointed* attacks as well as the combined." These "pointed attacks" refer to the fall of iron columns and girders from a height of 30 feet upon a fireproof ceiling never intended to carry anything but itself.

Mr. Tite contended that York stone would not yield to a fire above it, and again inquired for any proof of the effectual resistance of concrete to the action of fire.

Mr. Barrett said his system had resisted fire in dwelling-houses frequently, but it had not been tested by a fire in any large warehouse.

Mr. Scoles observed, that if the ceilings were plastered where these fires occurred, the concrete had not been tested.

Mr. Hesketh thought the case of Mr. Ald. Humphrey's warehouses unsatisfactory as a proof of the value of concrete. The fire did not get under that floor, and it was protected from above by the rubbish which fell upon it.

Mr. Boulnois contended it was the duty of the patentee to settle this point, which he might easily do by erecting an experimental house and setting fire to it.

Mr. Donaldson: No architect would use such a ceiling without plastering it, and it was in evidence that intense and long-continued heat would not damage the plaster.

Mr. Boulnois complained that insurance companies made no reduction in their charges where the patent was used. If the patentees proved it to be fireproof, this object might be attained.

Mr. Barrett said this rested with the proprietor of the building. The house in which his own offices were cost 3000*l.* or 4000*l.*, and was only insured for 600*l.*, just to cover the little damage that could arise.

Mr. Tite having referred to covenants to insure leaseholds to two-thirds the value, Mr. Wyatt said he had advised the Wiltshire magistrates not to insure their lunatic asylum; and Mr. Barrett said, that in the case of the Royal Porcelain Works at Worcester, where his system had been introduced, the insurance had been reduced from 7*s.* 6*d.* to 1*s.* 6*d.* per cent.

Mr. C. H. Smith referred to the causes which rendered some of the varieties of laminated York stone used for fireproof construction more destructible by fire than others. Those termed self-faced, having been naturally divided, and containing more clay to absorb moisture, which would be converted into steam by great heat, and consequently split, were the most unfit for the purpose. Under ordinary circumstances, he was of opinion that concrete, properly made, would bear a very considerable degree of heat; perhaps more than Yorkshire stone.

Mr. C. C. NELSON, in continuing the discussion on February 6th, observed, that on comparing the French and the English systems, which had been brought under consideration, one great point of similarity was found between them, inasmuch as the main supports in each were the rolled iron joists; on the other hand these joists were much closer together in the English than in the French system, in which latter, however, the iron entretoises, or transverse rods, were placed further apart than the wooden laths in the English system; while the material used for the filling in differed materially, being plaster of Paris, or plaster and hollow earthenware pots in one case, and concrete, formed of lime, sand and gravel, in the other. Neither of the systems under discussion could be considered perfectly novel; and indeed, so far back as the year 1849, a paper was read to the Institute by Mr. Donaldson, describing a mode of construction adopted by an engineer named Thompson, in a bridge over a railway near Glasgow, in which tubular iron girders, of boiler-plate $\frac{3}{8}$-inch thick, were made solid by the introduction of concrete between the plates to render them unyielding and rigid; the girders being then tied and framed together with bars of iron, the space between them was filled in by arched brickwork. With reference to the question which had been raised at the former meeting as to the expansion of concrete, Mr. Nelson referred to the "Essay on Concrete," by Mr. Godwin, in the first volume of the Transactions of the Institute, for which the first medal of the Institute was awarded in 1836, as containing the results of experience on the subject; clearly proving that concrete in setting did expand. As to the nature of the French plaster, M. Delassaux had forwarded the following communication in 1846, describing the difference between that material and the "plaster of Paris" used in this country, from which it would appear that the former was a much better material than the latter:

"The English plaster stone is a sulphate of lime, destitute of water, except a small portion of sulphuric acid; it is in fact an imperfect alabaster. The consequences of the chemical composition of this stone are, that burnt and reduced to powder in the usual way, it is not capable of resisting the vicissitudes of the weather, and the small quantity of sulphuric acid it contains prevents its setting quickly or becoming hard. It can consequently only be employed for interior plastering, and generally for works requiring but little solidity—its employment in construction is thus very limited. The stone of the French plaster of the environs of Paris is a sulphate of lime composed in the best proportions, the acids being almost equal to the bases; properly burnt it preserves all its acid properties, and reduced to powder and mixed it becomes very hard in one day. Unlike the English plaster there is no need to grind it very fine, on the contrary for strong work it is better to be rather coarse; it is only in decoration that it is employed as fine as the English. In France, along the borders of the Seine, the houses are constructed with this material; for solid construction, grouting the joists of stones, for exterior and interior decoration, and masonry generally, plaster of Paris is employed; for the latter purpose the powder is used rather coarse; mixed with water it forms a factitious crystallisation, which adhering to the materials employed gives them greater rigidity—thus a vault formed of stones badly dressed and ordinary mortar would have but little strength, but the use of plaster with its properties of adhesion and augmentation of volume would insure solid and durable work."

In February 1849, Mr. Charles Barry read a paper describing a system, patented by Mr. Beardmore, C.E., in which the same reliance was placed upon concrete, formed of Portland cement and shingle, for stiffening wrought-iron, as in Messrs. Fox and Barrett's flooring, drain pipes being in some cases introduced with the concrete for the purpose of lightness. For a span of 20 feet, iron plates, 12 inches deep, $\frac{1}{2}$-inch thick, and 2 ft. 6 in. apart, were used, a layer of concrete, 5 inches thick, being placed between them, on horizontal plates of iron, $\frac{1}{16}$-thick, secured by rivets to the sides of the upright bearers. The author thus described the use of the concrete. "The uniform pressure of the concrete against the surface of the web, and under the upper flanges of the beam, produces the effect of a continuous strut, and enables any sheet, however thin, to assume the true character of a beam or girder." For a span of 15 to 18 feet the depth of floor would be $7\frac{1}{2}$ inches; from 16 to 20 feet, 12 inches. Mr. Beardmore "considered his floors to be fireproof from their mode of construction; not liable to disintegration when exposed to fierce flame, as brick arches are by their falling off in flakes, nor to be destroyed by sudden cooling when highly heated. The thinness of the floor, when contrasted with one of cast-iron, and the absence of all lateral pressure, and consequent necessity for tie-bolts, were further advantages; in addition to which the concrete was a necessary element of the floor itself, not a weight independent of it, and it rendered the whole, as it were, one continuous beam, thus making it nearly impossible to accumulate a great weight on any one spot."

Mr. H. H. BURNELL, read the following extracts from letters which he had received from Paris, in reply to questions which he had forwarded since the first evening's discussion. The first was—

1. *A communication from* M. PIOT, *Sub-Architect employed at the works of the Tuileries and Louvre*:

"You ask me for some account of the iron floors we are now using in the new buildings of the Louvre. These floors are generally composed of girders and joists of the ≖ form. The joists are so proportioned that the deflection of the floor under a load of 700 kilog. per superficial mètre, or 143 lb. per square foot, shall not exceed 20 centimètres (or $\frac{3}{4}$-inch), which may be thus explained: We suppose that four persons might stand in the space of a superficial mètre (or $10\frac{3}{4}$ square feet), and that their joint weights might equal 300 kilog. or 661 lb.; we add as the weight of the interties, fantons, pottery, small wooden joists, and floors, 50 kilog., making 350 kilog. We double this load to make it equal to walking or dancing, and thus we arrive at the above-named 700 kilog. (1544 lb.) The following table gives the spans, weights, and depths of the joists employed in the floors of the Louvre:—

| Spans. ft. | in. | Weight of Joists per yard run, in lbs. | Depths of Joists. inches. |
|---|---|---|---|
| 6 | 7 | 18 | 4 |
| 9 | 10 | 22 | $4\frac{3}{8}$ |
| 13 | 2 | 40 | $5\frac{1}{8}$ |
| 16 | 5 | 50 | $6\frac{1}{4}$ |
| 18 | 1 | 54 | $7\frac{1}{8}$ |
| 21 | 5 | 60 | $7\frac{7}{8}$ |
| 25 | 0 | 76 | $8\frac{3}{4}$ |

We have adopted the above-mentioned spans, placing the joists 80 centimètres, or 2 ft. $7\frac{1}{2}$ in. from centre to centre, the interties 1 mètre, or 3 ft. $3\frac{1}{3}$ in. apart; the fantons are placed 20 centimètres, or $7\frac{7}{8}$ inches from each other, and serve to support the pottery in the usual way. The pottery is thoroughly bedded and plastered on both sides, rendering the floor as nearly as possible sound-proof, and infinitely superior in this respect to the ordinary methods. The strength may be judged of by the fact that some have been proved to 1500 kilog. per superficial mètre, or 307 lb. per square foot, and the deflection did not exceed 3 centimètres (or 1 inch) in the middle. In first-class buildings the filling-in is generally of pottery or hollow bricks, but in private houses they usually content themselves with plaster alone; it is considered inferior and less sound-proof. In general the wrought-iron floors are found to be of the necessary strength, and may be regarded as a great improvement, but in France, and particularly in Paris, the spirit of speculation is prone to exact too much from the material it employs."

2. *A communication from* M. LEBAS:

"I received the letter you were good enough to send me, and was glad to hear that you had written to M. Piot on the subject, for he is the most capable of giving the desired information, as he unites great experience with practice, which is better than all the theories. He has no doubt given you all the necessary proportions of the floors of the Louvre. Though it is certain that with these floors there is a small amount of vibration, it is no less certain, that when used with common judgment, they offer the desirable qualities of strength, durability, and incombustibility. Had I to undertake a building of importance, I should unhesitatingly adopt this system, which I consider excellent."

3. *A communication from* M. CHARLES HITTORFF:

"For dwellinghouses, the weight on the entire floor should not exceed one-fourth or one-fifth of the breaking weight, or limits of deflection of the joists, and it should bear the weight of four persons = 300 kilog. (651 lb.) per superficial mètre (66 lb. per foot superficial). When these limits are surpassed, a disagreeable vibration and a disposition to transmit sound is the result. As yet, the floors well filled-in with pottery or hollow bricks have developed no symptoms of failure, either with respect to vibration or transmission of sound; but they are considerably dearer than those of wood, though the manufacturers (quoting the first or cheapest system) pretend the contrary. This kind of economy is much to be regretted, as it may be the means of causing accidents which would tend to create a prejudice against this mode of construction. The difficulties of rolling, render the production of large joists very doubtful, as regards the equality of texture, and in many instances those of from 22 feet to 24 feet long, and from $8\frac{1}{4}$ inches to $10\frac{1}{4}$ inches deep, have broken on being proved; but nothing is to be feared from the employment of these methods for moderate spans. Has never known that these iron floors have been filled in with concrete.

which would load the floor unnecessarily. The ironwork is painted with a coat of litharge, to prevent oxidation; sometimes this precaution is neglected, and without ill effects; for after all, the oxidation can only take place by the double action of the oxygen of the air and water. The iron imbedded in plaster is at once covered with a coat of rust, but this action soon ceases when the plaster is of a sufficient thickness (say ¾-inch) to exclude the air. This fact is sufficiently proved by the fragments of iron we constantly find, while demolishing our old buildings, in a perfect state of preservation, though they have never been painted."

4. *A communication from* M. Dumont:

"Of the two systems of wrought-iron floors that you mentioned, this one is almost exclusively employed here. Prudent builders never allow the depth of the joist to be less than $\frac{1}{16}$th part of the span. The filling in between the joists is generally of pottery or hollow bricks, bedded in plaster; when the builder is not too sparing of his plaster, and the spaces properly filled-in, the necessary rigidity is obtained. We avoid the use of concrete on account of it weight; we find nothing answer so well in every respect as the pottery. We paint our ironwork with one or two coats of litharge, according as the speculator may be disposed. As to the quality of the work, I may state, that up to the present time the ceilings have not suffered from discoloration by the oxide of iron; I believe, that in the first instance, the paint is sufficient to protect the iron from the humidity and the corrosive qualities of the plaster, and at a later period, the plaster in its turn protects the iron from atmospheric influences. It must be acknowledged, that experience as yet can say little on the matter. In twenty, fifty, or a hundred years, we shall be better able to judge of the systems, but at the present moment they are so much in favour with us, that we very rarely have recourse to the old methods. In four houses that we are now erecting in the Rue de Rivoli, we have used these floors, three of them opposite the Tour de St. Jacques, and the other (which is the most important) between the Rue de Bourdomais and the Rue de Deschargeurs; we do not yet know the numbers."

Mr. Burnell continued—From these communications we may briefly sum up the following facts:—That the planchers-en-fer, if properly carried out, succeed, but that they, in common with all other modes of construction, are capable of being executed badly. We learn that the floors of the Louvre, though upon the same principle, are stronger than those ordinarily used for dwelling-houses. That joists of the depth and weight indicated in the table furnished by M. Piot, if placed 2 ft. 7½ in. apart and properly filled in, will produce a floor whose deflection shall not exceed ¾-inch in the centre, under a load of 143 lb. per superficial foot; and that there are others executed in the Louvre that have borne 307 lb. per square foot, with only 1 inch deflection in the middle. That for the floors of dwelling-houses, the weight on the floor should not exceed one-fourth or one-fifth of the breaking weight of the joist, or that the depth of the joist should not be less than $\frac{1}{35}$th of the span, when placed about 2 ft. 6 in. or 3 ft. apart; and lastly, that no ill effects have at present been experienced from the contact of the iron with the plaster. As I have before said, my object in drawing your attention to the matter in question was to induce a due appreciation of that which seemed successful, but not to extol it beyond its merits. I think we must all perceive that a valuable lesson is to be learned by the study of these French methods, when we consider their lightness, and the small space they occupy, when compared with the fireproof floors we have been in the habit of executing. The introduction of interties between the joists must surely be important, when the filling-in is of a material that swells in the process of setting, to say nothing of their use as transverse ties. The ceiling appears to offer its advantages on the score of durability and convenient execution; for how much more easy must it be for the workman to adjust a flat centering beneath the joists, and form the ceiling by the simple operation of pouring a composition in upon it, than the tedious process involved in our own method of lathing, and applying the various coats of plaster, in a very inconvenient position, from the under side. This mode of grouting from above is not peculiar to iron floors, but it requires a material that sets with moderate rapidity, which with us is more costly than with the French. I believe that the rare occurrence of serious conflagrations in France is mainly attributable to the use of solid plaster ceilings. All seem to agree that the frequent losses by fire, the discreditable condition of many newly-built houses, the fall of others, and the threatening aspect of the many more which must inevitably share the same fate, were there not a special Providence over ignorance and knavery, are sufficient causes to justify any attempt to introduce improvement; and when we consider the rapid occupation of very desirable positions by endless piles of mud and bricks, exhibiting little but a disposition to speculate and low cunning, we must all regret that our already great metropolis should continue to extend itself under the guidance of parties so little capable or disposed to develope constructive or artistic talent.

Mr. Christopher felt called on to offer some remarks upon what had been called the English system, as the results of considerable experience. He had spoken warmly in favour of that system when it was first introduced, and still thought well of it, though it had not been so much improved as he had expected. With regard to the kind of finished flooring, used upon the concrete, he observed that Portland cement in connection with elastic iron was objectionable from its rigidity and brittleness; and in many instances within his own knowledge it had cracked. Indeed, he did not know of a case in which it had remained sound for three years. This had been the case both with floors and with flat roofs, after remaining perfect for twelve months; and, as they were aware, when the Portland cement was once cracked, water spilt would penetrate through the concrete, and in the case of a floor would stain the ceiling below, whilst in that of a roof the damage would be much more serious; as there it was impossible to repair effectually the cement. It was difficult to account for this failure, but probably, as one of Mr. Burnell's French correspondents suggested, it might be owing to the expansion of the concrete. Whether the fault was in the cement or in the concrete, he had had failures in three roofs. However, the system admitted of other modes of finish, and amongst these he might observe that he had found the metallic lava of Messrs. Orsi and Armani quite successful after two years trial. The ceilings on the French system were, in his opinion, better than those on the English plan. In the latter there was the want of a good key, and this was a serious objection where the plaster was 1¼ or 1½ inch thick, while under the flanges of the joists and girders there was no key at all, and several serious falls of the ceiling had taken place. In the French system this could not happen, the whole mass being poured in from above; but in the English a separate material was applied to form the ceiling from below. As the object of this discussion was to ascertain the truth, he felt bound to say there had been several instances of ceilings giving way, not only under roofs, perhaps from the faultiness of the cement coating, but also in the floors below, and he had found it necessary very recently to take down the whole of several ceilings, in order to quiet the apprehensions of the tenants on this score. Another serious objection to the English system, especially in London, where expedition was required and ground rents high, was the time necessary for the materials to dry. The drying of a mass of material 8 or 9 inches thick and full of water, if in a confined situation, was indeed almost an impossibility. He had a case in which it had not dried even in two years, and in which it had been necessary to take up the surface of the lower floors entirely, and to employ another material. The floors in that case had been of lime and sand; after the building had been shut up for two months, the workmen (who were provided with slippers) went in to hang the doors, and the surfaces were consequently so worn and broken that they were destroyed. In the lower part of this building Portland cement was substituted for the original finish, and he might observe, as an exception to his former statement, that as a basement finish that material, about 1¼ inch thick, answered exceedingly well, the damp tending to preserve it. In this case the cement was laid on a concrete bed, 4 to 5 inches thick, upon the well rammed earth. As he had remarked some years ago, Fox and Barrett's system admitted of the best plans of ventilation and artificial warming, but this point did not appear to have been much attended to. This, indeed, with such a mode of construction, was more necessary than in the ordinary plan. The floors were so solid from wall to wall that no air could get through them, and therefore a special supply was necessary. From the same cause there had arisen a want of draught to the fire places, and consequently smoky chimneys. Mr. Christopher then proceeded to the question of cost, in which he differed altogether with Mr. Barrett. He had gone into estimates with that gentleman when iron was only half its present price, of 15*l.* per ton, and they could not reduce the price of a floor on his plan to the cost of an ordinary timber floor; on the contrary, it was about the cost of a timber floor of the best description, made in the best way. He objected to the course pursued by Mr. Barrett in his calculations read at the last meeting, and to the deductions he had made from the price of his floors in order to bring the cost down to the lowest possible figure. Thus Mr. Barrett made a deduction for an assumed excess of strength, but he (Mr. Christopher) could not admit that for a moment. To any person employing his patent Mr. Barrett would certainly not recommend any reduction of strength to correspond with this deduction from the price. Indeed, instead of making any deduction from the cost of the patent system, he (Mr. Christopher) thought certain additions should be made. In the first place better foundations were required than for ordinary construction. These would be necessary even in the country, on a maiden soil, and in a second-rate house in Pall-Mall he estimated the extra cost for the foundations, which were essential in using this solid and massive description of fireproofing, at 20*l.* In the Thames Chambers, an extra first-rate building, upwards of 10,000 feet of hoop-iron were used, at a cost of 46*l.*, rather more than half of which, or 25*l.*, he had considered necessary in consequence of adopting Fox and Barrett's system. Then, again, there was the license for the use of the patent to be added, which, in a dwelling-house, would be from 10*l.* to 30*l.* It did not appear, moreover, whether the hoisting and fixing of the joists were included in Mr. Barrett's price. [Mr. Barrett said they were included]. Then expense was incurred in cutting and trimming the joists for chimney breasts and projections, which in the case of the Thames Chambers, where there were fifty-five squares of flooring, he estimated at 10*l.* There was the painting the lower flanges of the joists, which he thought very advisable, and more so after inspecting the result of Mr. Smith's experiments on the table, and which the French architects appeared also to think necessary. [Mr. T. H. Wyatt, the Chairman, said, the statement of M. Hittorff was that the painting might be dispensed with; that its absence did not seem to produce any ill effects.] In all good rooms it would be also necessary to have a wooden fillet for nailing the carpets to. Mr. Christopher's estimates, framed on the result of his experience, would therefore be as follows:—

*For a Room* 12 × 12 ft. = 1 sq. 44 ft.

| | £ | s. | d. |
|---|---|---|---|
| Fireproof floor with cement surface—Mr. Barrett's price, omitting his deduction | 7 | 14 | 10 |
| Add for extra foundation and bond | 1 | 3 | 0 |
| License for use of patent | 0 | 14 | 4 |
| Hoisting, fixing, cutting, and painting—say | 0 | 7 | 10 |
| | 10 | 0 | 0 |
| Add extra for boarded surface | 1 | 16 | 0 |
| | £11 | 16 | 0 |
| Cost of timber floor, pugged—Mr. Barrett's price | 8 | 15 | 4 |
| Excess in cost of fireproof floor | £3 | 0 | 0 |

*For a Room* 20 × 20 ft. = 4 sq.

| | £ | s. | d. |
|---|---|---|---|
| Fireproof floor with cement surface—Mr. Barrett's price, omitting his deduction | 32 | 4 | 3 |
| Extra coat on ceiling, 44½ yds.—@ 2*d.* | 0 | 7 | 5 |
| Extra foundations—@ 7*s.* ℔ sq. | 1 | 8 | 0 |
| Extra hoop-iron bond—@ 9*s.* | 1 | 16 | 0 |
| License for use of patent—@ 10*s.* | 2 | 0 | 0 |
| Hoisting, fixing, cutting, and painting—@ 5*s.* | 1 | 0 | 0 |
| Wood filleting for carpets—say | 1 | 0 | 0 |
| | 39 | 15 | 8 |
| Add extra for boarded surface, with 1½ in. battens, @ 32*s.* | 6 | 8 | 0 |
| | £46 | 3 | 8 |
| Cost of timber floor and ceiling of best description, Mr. Barrett's price | 31 | 12 | 3 |
| Excess in cost of fireproof floor. | £14 | 11 | 5 |

Upon the whole, therefore, he thought Mr. Barrett's estimates were not to be depended upon.

Mr. C. H. Smith called the attention of the Meeting to some specimens in illustration of the effect of plaster upon iron. In these specimens he had placed different materials in contact with iron on the day after the last meeting (a fortnight ago), and the results were now evident. In one specimen plaster of Paris alone was used, in another plaster mixed with sand, and in another mortar, or lime and sand in equal proportions. In the latter not the slightest trace of rust was perceptible, although the interior of the mass was still in a very soft state, whilst in the other specimens, especially with the plaster of Paris, the iron was sensibly affected. Plaster of Paris decreased in hardness in proportion to its age. As an illustration of this, Mr. Smith stated that he was employed some years ago to remove from the residence of Mr. Prince Hoare, at Bath, to London, eight or ten large casts from the antique, which had been there a hundred years, but he only succeeded in removing two of them safely; the rest having fallen entirely to pieces. Lime, on the contrary, increased in hardness with age, and iron in contact with it was not affected. As the specimens proved, plaster was most injurious. Paint would protect the iron, but if it became rubbed off, even in the smallest pin-hole, the plaster would communicate oxidation to the iron, to an extent almost beyond belief, and in fact would in time entirely destroy the iron. He believed it would be found almost impossible to fix iron joists in a building so that the paint or other coating used to protect it should not be rubbed off in some parts, and even galvanised iron was subject to the same objection.

Mr. Garling inquired if the old casts referred to by Mr. Smith had been exposed to damp.

Mr. Smith said they had not; but that there was always a sufficient amount of moisture in the atmosphere to facilitate the decay of plaster.

Mr. Garling referred to some plaster floors which he had seen in Lincolnshire, in the vicinity of the quarries. These consisted of a body of coarse plaster, with about an eighth to a quarter of an inch of fine plaster as a surface, very finely and smoothly trowelled; and although these were from 100 to 150 years old, they were now as hard as marble. He had also occasion to take down the plastering of the walls of some rooms in the same neighbourhood, which was at least 300 years old; this was 30 or 40 years ago, and, speaking from recollection, his impression was that the plaster in that case was quite as hard as in the floors. It was suggested that these floors were possibly of lime, and not plaster, but he was quite sure they were of plaster.

Mr. G. R. Burnell, C.E., referred to the work of Rondelet—'L'Art de Bâtir'—on the different nature of lime and plaster as to durability, in confirmation of Mr. Smith's remarks, and read some portion of his letter to Mr. Nelson:

"I would call your attention, and that of the members of the Institute, to a work I mentioned on the last evening; it is M. Eck's Traité de la Construction, Poteries, Fer, Fonte et Tôle,' in two vols. fol. Paris, 1841; in which will be found many very remarkable illustrations of the application of those various materials to purposes which rarely are thought of in England. It is an extremely valuable work, and if it had been better known here, probably much money might have been saved by preventing parties from taking out patents for systems already largely employed; and at any rate, the study of M. Eck's book would have suggested many valuable hints to both architects and engineers. At the same time, I would also beg to call the attention of the Institute to a note I published myself in the *Builder* of 1849, page 350, in which I gave a short description of the application of the Ꮋ shaped rolled iron: I allude to this because I have reason to believe that the application of this kind of bar iron to flooring purposes has been patented subsequently to the publication of my note in the *Builder*. In Paris, it was used, to my knowledge, in 1848."

The nature and application of compound wrought-iron beams with earthen pots for roofs were described by Eck as known so long ago as 1780, in whose work an account was given of the church of San Vitale, at Ravenna, the dome of which is formed of oil jars, laid horizontally; a fact which would set at rest the question of the supposed novelty of this use of pottery.

Mr. Scoles referred to the use of similar materials, in the Roman period, in Syracuse, and Mr. Donaldson added also that they were employed likewise in the Circus of Caracalla.

Mr. G. R. Burnell read a further portion of his letter to Mr. Nelson:

"The formulæ given by General Morin are as follows: 1st. For the Système Vaux, he considers that the bars are exposed to the action of a load distributed equally throughout their whole length, and that the ends are fixed in the walls; the weights and dimensions are calculated in mètres and kilogrammes

Then, calling the height of the bars, or main ribs $= b$
Their width . . . . . . . . $= a$
The load per mètre lineal . . . . . $=$ P
The clear span . . . . . . . . $=$ C
The coefficient of the resistance of wrought-iron $= 2,000,000$

$$a\,b^2 = \frac{\mathrm{P\,C}^2}{2,000,000}.$$

In practice, the load per mètre lineal usually applied (at least, for the purposes of calculation) is 53·28 kilog., or about 37 lb. per foot lineal; and the joists or bars are placed at distances of about 2 ft. 6 in. apart.

"2nd. In the cases where rolled Ꮋ rails are used, the height $b$, and the projection of the flanges $a^1$ are constant for the same class of rail, and the thickness of the flanges is usually $\frac{1}{20}$th of $b$. The thickness of the centre web $e^1$ is the only element of the problem in these cases which varies according to the resistance to be given to the bars. Then, calling the total load $=$ 2 P, and the total bearing $=$ 2 C, and the resistance for this form of section R, $=$ 6,000,000, we have

$$\frac{\mathrm{I}}{v'} = \tfrac{1}{6}\,e_1\,b^2 + 0{\cdot}0903\,a'\,b^2;$$

in which I $=$ the moment of inertia of the section in function of the height $b$, and $v^1 =$ the height of the neutral axis of the bar. The ordinary formula $\frac{R\ I}{v'} = P\ C$, then becomes

$$\tfrac{1}{6}\, e_1\, b^2 + 0{\cdot}0903\ a' b^2 = \frac{P\ C}{R} = \frac{P\ C}{6{,}000{,}000};\ \text{and from this}$$

$$e_{1,} = \frac{P\ C}{1{,}000{,}000 b^2} - 0{\cdot}54\ a'.$$

When the proportions between the thickness of the flanges and the height differ, the general formula becomes $\frac{I}{v'} = \frac{1}{6}\,\frac{ab^3 - a'b'^3}{b}$, in which $b'$ = the space between the ribs.

"I was not quite correct in the observations I made upon the deflection of these floors, on the occasion of your last meeting, and I therefore send you a translation of an experiment recorded in pages 331 and 332 of Vol. IV. of General Morin's 'Leçons de Mecanique Pratique,' which treats of the resistance of materials:

"'A floor of about 23 feet span (7 mètres), on the system Vaux, with joists 2 ft. 6 in. apart, 7½ inches deep by 0·36 of an inch in thickness, cross ties 0·63 of an inch square, and split rod laths 0·43 of an inch square, the joists bearing about 1 foot on the walls, was loaded with a weight equal to 102 lb. per foot superficial over the whole surface. The iron work was set with a camber of about 2¾ inches when in place; the filling in with plaster brought this down to 1·68 inches; and when the load was applied, the floor sunk to 1·17 inches below the horizontal line, which deflection ultimately became (after 24 hours) 3·17 inches. On removing the load, the floor rose 2 inches, and on further removing the plaster filling the ironwork rose nearly to its original camber, or to 2·36 inches above the horizontal line.'

"General Morin remarks that this experiment proves that the iron retained its original elasticity to a great extent, and that the plastering contributed greatly to the permanent deflection. Mr. Barrett's objection to the use of the French floors—that they were not perfectly inflexible, and his statement that the plaster used in the Midland counties was objected to on account of its organic smell,—seem both to require notice; for, in the first place, a mere augmentation of the scantlings would give any required rigidity; and, in the second, Mr. Barrett appears to have overlooked the fact that the French plaster, both geologically and lithologically, differs from that of our Midland counties."

Now, the French plaster contained carbonate of lime, which the English plaster did not. Possibly English plaster, used in large masses, might give out some odour; but certainly he could state from experience that the plaster used in Paris was not open to that objection. Where French plaster was used in conjunction with brickwork, a remarkable degree of efflorescence took place, which might arise from animal matter either in the bricks or in the plaster, or perhaps in both. At all events animal matter did not exist in the French plaster to any objectionable extent. Mr. Smith's statement that lime protected iron from rust should be received with caution. All the wrought-iron bridges in France had been built upon the principle laid down by Vicat, that no oxidation could take place whilst iron was immersed in slacked lime; and accordingly the tying-down rods of these bridges were bedded in wells, with a paste of chalk lime carefully rammed in. Yet all those bridges had fallen; that at Angers at a time when 600 persons were upon it, more than 400 of whom were drowned. The explanation of this failure possibly was, that the action of the load upon the bridge set the chains in a state of vibration, which, though not perceptible to the eye, was yet sufficient to detach the rods from the lime in which they were embedded; upon which water could get in, and the oxidation would commence. Mr. Smith's principle was correct; but in a floor of any kind there must be some degree of vibration, which would tend to detach the joists or girders from a bed of lime in which they might be placed. He believed, in fact, that concrete or lime in any form was not better than plaster, which being more hygrometric than the mortar would rather protect the iron more securely. Practically, in a house, the plaster was a sufficient defence to the iron, and this was what the French architects meant, when they said they had not noticed any rust in the use of this material.

Mr. SMITH observed that it was not necessary that lime should be absolutely in contact with iron to protect it from rust. Thus the dealers in polished steel goods, such as needles, did not coat every article with lime, but merely placed here and there amongst them a piece of quicklime in paper, which kept them in a polished state as long as the lime continued in a caustic condition.

Mr. G. R. BURNELL said that this remark did not apply to the French bridges. In the case put by Mr. Smith, the caustic lime not being as yet converted into a hydrate, acted by absorbing moisture from the atmosphere.

Mr. GARLING suggested that if the chains of the French bridges were bundles of wires instead of solid bars, the interstices in the wires might have conducted the water into the wells.

Mr. T. H. WYATT (the Chairman) stated that the names of two gentlemen had been given to him as wishing to offer some remarks upon the subject; and that it would be only fair to Mr. Barrett to allow him to say a few words in reply to Mr. Christopher. As therefore the discussion had already occupied the usual time, he proposed that it should be further adjourned till the next ordinary meeting.

Mr. BARRETT, in reference to Mr. Christopher's statement that extra foundations were necessary in using the patent system of flooring, begged to appeal to Mr. Beck, who might not be able to attend at the next meeting. As architect to the Metropolitan Association, that gentlemen had erected a building five stories in height, all the floors as well as the roof of which were fireproof; and he would no doubt bear testimony to the fact that extra foundations were not used there.

Mr. BECK said that this was the fact, and that, in the case referred to, he had not introduced any additional brickwork in the foundations, in consequence of using Messrs. Fox and Barrett's floors.

## SYMBOLISM IN ART.*

THE question of Symbolism in Art is one interesting to artists, but we fear the writer who is now before us is not the one to treat it in a right spirit. It needs a catholic treatment, but the author has chosen to treat it in a sectarian spirit. Professing to treat the subject on first principles, and impartially, he has written in a theological sense, appealing to conventional authorities, and we fear therefore he will raise more opponents than supporters.

In discussing the question of the admission of symbolism in art, we ought perhaps to define what is or is not symbolism, and afterwards how far symbolism is rightfully applicable. Mr. White appeals only to one of his co-sectarians, who is evidently regarded by him as an infallible authority, and indeed great veneration is shown by Mr. White for authority. The canonist appealed to, has, it seems, been pleased to define symbolism as the "having something in common with another by representative quality." How this is applied, and how it is worked out, we are not able to ascertain from Mr. White's dissertations. We can understand that symbolism which appeals to badges, armorial bearings, cyphers, inscriptions, and other types of men and things, but this does not seem to express the views of Mr. White and his coadjutors. He asserts "that the works of *nature* have an inner meaning, cannot be denied," and this, he says, "is acknowledged on all sides;" as a proof of which, he refers to some sectarian tract, called the 'Christian Year;' and then he goes on to adduce a mass of scriptural quotations, and likewise citations, from St. Basil and the herd of schoolmen. Upon such a basis he builds up a system, which he calls Symbolism, but which others would call Mysticism, for everything is made to speak any language, though to the many, we fear, unknown tongues.

On this topic, Mr. White says, "Our Lord may be symbolised by the vine, the lion, or the lamb; and so likewise may be symbolised by Water, cleansing from Sin, 'the waves of this troublesome world,' or the deep sleep of death. Of what an infinity of thought may even water itself be suggestive, whether we contemplate it as filling the ocean, or ceaselessly flowing down in 'the springs and rivers which run among the hills,'—whether we think of it in its vast extent, its motion and life, its obedience to the Sovereign command, 'Here shall thy proud waves be stayed,'" and so on *ad libitum*, and we may say *ad nauseum*, for it is calculated to bring symbolism, and even religion, into ridicule. Lord Burleigh's shake of the head did not mean as much, and Dean Swift's Meditations on a Broomstick could not have been made so diffuse as this one thing—Water—in the hands of a patristic commentator. Water, or any other substance, may mean all these things, and many more, to him who chooses to imagine them; but what are the many, the multitude, likely to understand of all these fantastic applications, as recondite and far-fetched as the gambler's sermon from a pack of cards? This brings us to one test of symbolism, and which points out the distinction between symbolism and mysticism, and the bounds of symbolism. The symbols to be applicable in architecture must be such as will be felt and understood by the many, and not by the few, for it is to the many that architecture in its noblest

* Is Symbolism Suited to the Spirit of the Age? By WILLIAM WHITE. London: Bosworth. 1854.

monuments appeals. The statue may be secluded in a niche, the picture worshipped by a select body of connoisseurs in the cabinet; but the temple, the church, the monument, stands forth in the broad light of day,—to be seen by the lettered few it is true, but to be seen likewise by the thousands who throng the crowded thoroughfares, and, it may be, to be seen by tens of thousands in ages to come. The more educated may better appreciate the excellences, but those sentiments must be complied with which animate the mass of men, and the many have never failed in any age or clime to admire the truly beautiful.

So far, the application of symbolism in architecture is narrowed, but the body of worshippers is enlarged; though, after all, symbols must to a great extent be local and partial in their application, and can only be looked upon as accessories, ranking below those conditions of beauty which are the first requirements of art. In this application, symbolism has certainly been acknowledged in all ages and by all men, each according to the fashion of the time, and in so far, symbols are vital members of the repertory of art. Under these conditions, symbols are commonly and readily recognised, and have their great power; but when symbols are multiplied in number, and still further multiplied in meaning, and when they are converted into logotypes of theological subtleties, Mr. White is no longer justified in applying to them his trite quotation:—

> "Segnius irritant animos demissa per aurem,
> Quam quæ sunt occulis subjecta fidelibus, et quæ
> Ipse sibi tradit spectator."

The whole force of Mr. White's corroborative examples is here lost, because, while the thing itself is conveyed to the mind of the spectator, the hidden meaning makes no impression. When people look at the *Illustrated News*, they do, as Mr. White says, look at the engravings first, and conceive a stronger idea of the incidents recorded than from the perusal of the text; but if they look at the engravings of the rebus in the *Illustration* or any French publication, instead of such clear idea being forthwith conveyed, the mind is puzzled to make out the meaning,—time is lost, perhaps the attempt abandoned, and no impression is communicated.

Mr. White does not however, seem to be of this opinion, for he boldly assumes that symbolism has its offices and supposed uses. "In that symbolism embodies or expresses spiritual truths by material forms (1), it may be made a means of conveying to men's minds a lively and intelligible impression of such truths; and (2) it may remind men of these truths by objects which they continually see around them; so that wherever they go, and upon whatsoever their eye rests, something shall recall to their thoughts one or another of those realities in which man's truest and deepest interest lies." It is not within our province to discuss the theological principles of Mr. White or any one else, because architecture is a catholic and sectarian art, and because our readers here are men of various religions—Christians, Jews, and Englishmen; and abroad others, Parsees, Mahometans, and Brahmins, men of many nations; but we may say, that the principles advocated by Mr. White are, on artistic and natural grounds, fatal to any religion. Its truths should be impressed on the mind, and they will not be confirmed by teaching the votaries to regard every object in an unnatural sense,—for that is the purport of this teaching. We are not to look upon objects of nature in their visible appearance and meaning, but we are to consider them as fanciful records of immaterial and remote doctrines,—we are to look at everything monomaniacally, and under a delusion; nothing is to be what it seems, but anything but what it seems. Architecture certainly does not admit of this treatment, and the attempt, whenever made, has failed. The symbols of the Egyptian temples were plain and direct records, many of the decorations were pictorial representations of events; and the same may be said of the Parthenon; nor in the middle ages did the schoolmen succeed in imparting to the public, by architectural accessories, their fanciful doctrines. The public then, as now, forebore to participate in these mysteries, and the revivalists alone of the present day can adequately appreciate the latent significations of the *vesica piscis*, and the multifarious whimsicalities with which brainsick imaginations have filled volumes of commentaries. The truths of religion must be implanted in the mind; they are essentially immaterial, and theological doctrines cannot be inculcated in their comprehensiveness by the architect. Personages may be commemorated, and personal worship may be symbolised; but that is the limit of the power of the architect and the sculptor, his fellow-labourer, and even when the painter is called in, the domain of interpretation can be but little extended. A fallacy is therefore involved in the deductions from Mr. White's *petitio principii*, and our readers will not therefore be prepared to admit his premises, or his affirmation "that certain truths should be impressed on men by visible objects as well as by words, is advantageous on many accounts; partly because the eye, as well as the ear, thus becomes a means of conveying instruction to the heart."

Starting from such a basis, the author is led to the most fanciful conclusions when he proceeds to expatiate on what he calls the field of sacred art. It might be thought that the dedication of a church is sufficient in itself as an inculcation of religious feeling, but not so thinks Mr. White. It is not enough that he has his congregation in a church,—he is not content with the provision for devotional influences; they are no better off in his mind's eye than in a playhouse,—he would further surround them with an extensive apparatus of devotion, so that he may fully control the thought. The worshippers are to swim to heaven in cork jackets, or the architect is so to minister that the devotee may not rest his eye anywhere without religious sense being fastened upon and enchained; for Mr. White affirms, "Great are the difficulties of disciplining and restraining the thoughts at all times...... But above all other times and places, men have most need to look to their thoughts when they go to church, where, from the nature of the case, they are for the time cut off from natural teaching; yet still they need to be reminded of Him," and so forth; and therefore the architect is to co-operate in the machinery of asceticism.

Mr. White, it is true, does allow the architect to avail himself of the sublime and beautiful, but he wishes for beautiful forms which contain a meaning beneath the outward expression. How this is to be attained we know not, for the sphere of mathematical symbolism is restricted; but the writer in his fervent zeal is adventurous, for he hopes to keep perpetually before us some phase of the heavenly kingdom, and to realise more truly the presence of God and the Communion of the Saints. The writer has not laid down any scheme for doing this, but he gives numerous examples of his system of interpretation. The exterior of a church affords him notes enough for a volume, and in the interior there is enough to occupy him. On entering the porch, says he, the visitants will be reminded of their Lord's saying, "I am the door of the sheep," and of the impossibility of gaining admission to the heavenly kingdom, but through Him, the Door. This we very much doubt, for there is not one in a thousand Englishmen who will call to mind any such thing; nor is there any need they should, for they will be much better reminded by their prayer-books in the due course of the service. But then, says the writer, the font speaks of new-birth, and of being buried with Him in baptism; the nave, of the ark of Christ's church: and this it will be seen is the type of a type, and how the architect is duly to transmit a succession of types and tropes passes comprehension.

In the same spirit, the aisles are to speak of the extension of Christ's kingdom, when the building should not be large enough to receive them; the chancel, of those who are chosen out of the multitude to minister about holy things; and the sanctuary is to teach a further lesson of the same kind. The writer then goes to details: the pillars speak of the firm supporters of the faith; the arches, of the mutual support of all the brethren; the roof, of the shelter from the blast; the windows, of the light shed down from on high; the uniformity of fittings, of the perfect equality of all in his sight before whom all there appear. He even points out meanings in the turnings of the minister and congregation; nor does this exhaust the subject, for he urges upon the architect that not the main features only, but every minute portion of the building may suggest something good, and a lesson may be learnt even from the scraps of rich sculpture which are sometimes observed in the gloom of a retired corner or an unfrequented aisle.

All this is stated in good faith and with perfect seriousness by the author, in a work which is put forward as a sober exposition of symbolism against objectors. When the so-called symbolism is attacked we are warned that we are on privileged ground, and that the subject must be approached with care, deference, and circumspection, paying due reverence to the great authorities who have upheld it. We have therefore thought it useful to allow this exposition of the system to appear, so that it may be seen that it is not we who have thrown it into ridicule, but its advocate, who has even involved religion. We have given this exemplification because the architect is not only expected to carry out the views here expressed, but he is exposed to the peremptory dictation of the ecclesiologists, who require his submission to their mandates. In obedience to them the artist is to be deposed from his proper directing functions, and is to accept new canons of art, and it becomes him to consider whether he will so submit. He has before him the formula to which his adhesion and subscription are required.

We lay down this position thus clearly and thus broadly, because, as in Mr. White's work, we are required by the ecclesiologists, first to admit symbolism as a recognised catholic principle and practice in art, and when we have done so we are are invited to accept their peculiar theological system in its entirety and its minutiæ; and if we accept we are led to a career of artistic and mental debasement, to the abdication of truth, the abnegation of private judgment, and in the end to blind submission to blind dictators. There is no need, as it seems to us, to accept any such conditions: we may admit symbolism in its principle, and we may carry it out in its just application, without any fear that the cause of art will be lost if we refuse to mortify ourselves in the frock and profession of a barefooted friar.

We believe we have given enough to show the exact tendency of Mr. White's teachings, but we will enforce it by some of his special illustrations. In like manner he says, to architectural details particular forms and proportions, colours and numbers, were suggestive of great truths. Indeed, the two latter, according to him, have ever been considered to contain definite meanings when used in the scriptures, and were much referred to in the interpretation of it by writers of the church in all ages;—granted, but not by the people. Proceeding to colours, he asserts that red, being a symbol of warmth, may remind men of that divine love the fervent glow of which should fill their hearts. Green, being the ordinary colour of the face of nature, is a symbol of coolness or repose, and hence of the usual routine of daily duty when uninterrupted by any festival. White symbolises cleanliness or purity; and black or grey is a fitting emblem of penitence and grief. To all these he attaches further mystic meanings, and he proceeds to speak of certain feelings as being usually associated with particular colours,—black for instance, though we know that white, yellow, purple, and other colours are elsewhere adopted as the garb of mourning. With regard to technical theological emblems, he says that the cross is sometimes irreverently treated in being converted into something that is worn for mere ornament or intended for some common use, as for handles, clasps, and pencil-cases.

## BATHS AND WASH-HOUSES.*

The progress of baths and wash-houses has been referred to by us on occasions when books have been published on the subject, and it is evident there is a growing interest on the part of the public and of professional men, as well as of philanthropists. The architects and engineers first engaged on baths, with great spirit and liberality, published full accounts of their works, and we believe that they, as well as the public, have profited by their liberality. Great improvements have been effected, and such a reduction of expense, as to make a bath an essential and practicable establishment in every country town. Thus a field of employment is opened in the construction of several hundred buildings, of which we hope the beginners will have their fair share. Among the professional works on baths are those of Mr. P. P. Baly and of Messrs. Ashpitel and Whichcord, and now we have before us one by Mr. Cape, which, though not of a professional character, is well calculated to promote the movement; because, besides the necessary constructive information, it enters into the financial and practical workings of the system. Mr. Cape is the Secretary of the Lambeth establishment (formerly the swimming-baths), and he has devoted considerable zeal and intelligence to acquire and impart information on the subject of his employment. Thus his book will be found a very useful manual on baths and wash-houses for towns of all classes, and may be consulted by every one interested in the subject. We see so fully that the subject is an important one, that we think it worth while to devote a larger space to it than we should on the simple ground of Mr. Cape's book, or any novelty of treatment introduced by him. We regard it with a professional eye, not merely as a mode of employment, but as offering opportunities for novel constructive expedients, and for considerable mechanical improvements. It is not a field of routine occupation, but one the successful cultivation of which will, by its experience and example be beneficial elsewhere.

Mr. Cape, in his zeal for his subject, thinks it necessary to go back, like a German, to the beginning, and shows us that the most ancient nations were in the habit of washing, of swimming, and of using artificial bathing expedients. This our readers will be content to take for granted, and even that ducks swim, although Mr. Cape treats his theme pleasantly. He gives likewise a brief sketch of the great baths of the Romans—examples which we have yet to imitate and rival. The author comes nearer home when he appeals to the love of our people for bathing, and the duty of gratifying that habit. As the English are a seafaring people, so also are they a bathing people. They are a people fond of the water, and take to it from boys, whereever they have the chance. We think, nevertheless, that Mr. Cape speaks rather as of the school of mock-modesty, or perhaps as the official of a private bathing establishment, when he says that delicacy has forbidden the use of rivers and streams for public bathing. Delicacy, we believe, has done nothing of the kind, but the new police have. The English people—men and women—when left to themselves, and unmolested by continental influences, are a people having sufficient native good not to be offended with what in itself is not evil, and which has the merit of some good attached to it. It is not so long ago when, before steamers drove pleasure-boats off the Thames, the river was on a fine summer's day covered with thousands of men and women of all ranks, enjoying "the silent highway," while the men and boys gambolled in its waters. There was neither indecency on the part of the swimmers nor indelicacy on the part of the bypassers. For hundreds of years this great thoroughfare was a chosen scence of pleasure; and the pages of our poets and classic writers describe what many of us have seen, and what the pencils of our artists have depicted—the water parties on the Thames, where beauty, wit, and music gave additional charms to the scenes around. In those days, an aristocratic party making the trip by water to Vauxhall or Ranelagh, were no more shocked by the swimmers than by the Apollo and the Venus in the pleasure-gardens they visited. True modesty forbade it, and both modesty and taste would have been wounded by a mock-modesty which would have been too strong an evidence of indelicacy of thought. After the war had ceased, and some of our population had learnt modesty in that great school of outward virtue and consecrated vice, Paris, there was certainly an amazing outburst of propriety,—the legs of pianofortes were then dressed in trowsers; but our transatlantic cousins have long since been in sole and undivided possession of our cast-off forms of prudery.

In the better days we speak of, a noble lord had his address as "Swimming in the Thames opposite Whitehall;" and there was hardly a man in London, young or old, who had not bathed in its stream. Much of the employment of the watermen was derived from taking out bathers to some favourable spot for exercise. In those days, all classes bathed; and the general feeling of the community was sufficient to check any impropriety—which would, indeed, have been attended with summary chastisement. The entry of the up-river steamers, and the interference of the new police, have so much checked the practice of bathing, that the wholesome influence of the better classes is no longer felt; and as it is an act of daring to enjoy a favoured amusement, many of the rougher classes of society take part in what is often a public act of defiance. The love of bathing is however, as Mr. Cape says, as strong as ever, and it has not been without its influence on the public baths. Formerly the public baths were swimming schools, in which practice was gained for the Thames, the Lea, the Wandle, the Ravensbourne, the Serpentine, or the canals. On the river being virtually closed, the baths fell off, and some of them were shut up. The possession of such a noble bathing place as the Thames—one grander than the Baths of Titus—was the reason that London had no great public baths; and when deprived of that, it remained for some time without baths, and making a bad show as against Paris and other cities. Ardent swimmers sought suburban streams and ponds, but the police

* 'Baths and Wash-Houses; the History of their Rise and Progress: showing their Utility and their Effect upon the Moral and Physical Condition of the People; with Copies of the Accounts and Statistics of the Metropolitan and Provincial Establishments, and Practical Hints to those concerned in their Erection, and for their Management, illustrated with Plans, &c.; also a History of the Baths of the Ancients; and a Description (with Plan) of the Lambeth Baths and Wash-Houses.' By George A. Cape, jun., Secretary to the Lambeth Baths and Wash-Houses Company. London: Simpkin, Marshall, and Co. 1854.

beset them and drove them back into the town. In time, a reaction took place; more proprietary baths were opened, and the movement for public baths was powerfully aided by the public feeling. Mr. Cape makes some interesting remarks on the strong love of bathing which is shown, and he points out that most of the existing baths and wash-houses are deficient in adequate accommodation for swimming. At the Lambeth Baths, he has found ragged and seemingly-famished lads pay their twopence to the swimming-bath, when he thought they might have better spent the money on a dinner. Upon this topic of swimming, we shall make some remarks by-and-by, as we consider the claims of the public have been neglected, and that Mr. Cape is rather an advocate for the companies than for the public.

In protesting against Mr. Cape, we have been led into some remarks on the naked swimmers, and we have done so with the further purpose of making a further side-note for the consideration of some of our artistic friends, and that is as to the lessened display of the nude human figure. In the last generation the swimmer came under the eye of man and woman, and the prize-fighter, the sparrer, and the wrestler under observation of all the male community. The love of animal form in the horse, the dog, and in cattle is unlessened; but we are inclined to think that the familiarity with the naked figure, at the period we refer to, had much to do with the enthusiastic reception of the Elgin marbles, the admiration for the Flaxman designs, and the display of the nude in monumental sculpture and historical painting which marked the first quarter of this century, and is in opposition to the buckram professions of an influential body of the middle classes. It is true this display was made under the inspiration of an ill-directed taste, which now commands little sympathy for the *chefs-d'ouvre* of St. Paul's or Westminster, but nevertheless it manifested artistic aspirations as notable as pre-Rafaellitism, and perhaps more lasting in its influence. There certainly is for the nonce a less display of the naked figure, and the manly form divine is now muffled up in quaker garb with nothing picturesque to distinguish it but its incipient beard and moustache, and those who are fond of referring to the influence of the heroic games and gymnasia of Greece as influencing ancient art, may sigh for the change, but they may perhaps be comforted in the hopes of a reaction. The mediævalists and the pre-Rafaellites have given the draped figure a pre-eminence on the canvas, and the pious members of the community may rest self-satisfied with the sober coats and hats which shroud our population, but the population itself is not so satisfied. The women have shown a greater taste in dress than at almost any period, and this is not without its effect on the male population. There is a rather strong conviction that the tailor and the artist are in antagonism, and the public seem only to await a favourable opportunity to break out in open rebellion against their sober elders and the tailors. Sometimes there is a hat movement, now a beard movement, and in a trice we may find the population metamorphosed. Half-a-century ago the nation sacrificed at the shrine of art their wigs, their pigtails, and their cornered hats; and perhaps in the excitement of mind at the present war, the cylindrical head cover and the straight-cut coat may be offered up with like unanimity. The antagonism of the present costume is however most strongly shown when questions of monumental commemoration arise. Shall Wellington, shall Peel be represented as he lived and was, and as we knew him, as an Englishman, a great man in a great country,—or shall he be dressed up in the toga of the effête Roman republic, or the armour of the declining empire? Such is the question which arises, and truthful representation and the artist are in antagonism.

We have thus incidentally touched on an artistic question connected with the great problem of the future in art, which the architect anxiously scans. He looks back, and his ancient landmarks seem to fade from him. The quasi-classical in art has received a fatal blow to its monopolising claims, mediæval restoration is stigmatised as out of keeping with the character and spirit of the age, and there is a new class of structure arising, which will certainly prevail over a large architectural domain. The constructive expedients which have determined the formation of our wide-spanning railway stations and our crystal palaces afford the materials for a new style of art, and in this the bath will take its place. In reading Mr. Cape's work we have been powerfully impressed with this. The present baths, it is true, are relatively small buildings with numerous comparatively small chambers, but, as we have already intimated, he shows that the provision in these for swimming baths is not adequate. The swimming bath, he well states, as compared with the private, single, or plunging bath, is cheap in its construction and cheap in its maintenance. A smaller supply of water and a less rent is needed, and one or two attendants may supervise a large establishment, but a single attendant cannot properly serve more than a dozen bath compartments.

Thus there is scope afforded for large baths for swimming, and these may become of an extent of which at the present time we have no example. In the case of an embankment on the Thames, or in some districts on the shores of the river, it would be possible to form enormous swimming baths, spanned by large roofs, economically supplied with water, and affording ample space for exercise and practise. We may contemplate a bath half-a-mile long with one vast area of roof, the breadth of the building being of less importance than the length. With such a structure—and we know it is within the compass of art—the architect would have the opportunity of producing effects as remarkable in their character as colossal in their extent, and this is only one instance among many promised by the present tendency of progress and improvement. The vast extent of the structures and the novelty of the expedients employed have already resulted in a nullification of the ancient styles, if they have not yet created a new one. The Parthenon cannot be adapted to a crystal palace, nor York Minster to a railway roof, and the new structures will in time create their own styles instead of the styles creating the structures. The basilica grew into the mediæval cathedral because it had received a new impulse and inspiration, and the progress of the mediæval cathedral was largely influenced by constructive expedients. The adoption of glass and the mode of illumination determined the form of the walls, of the openings, and even of the roofs, as compared with the ancient temples of Memphis, Athens, or of Rome; and so too, will the vast glass roofs and walls of the new edifices determine the character of their details. The sturdy, close, and stunted columns of Egypt became impossible in a crystal palace, and will not therefore be repeated, and other forms of ancient art will likewise become obsolete. Thus, by the legitimate force of circumstances, we shall be really and truly led to a modern and perhaps a national style. The adoption of the arch gave its character to Roman architecture; and that of the light and vastly-expanded roof will become the type of the architecture of the nineteenth century in a great proportion of its monumental structures.

We are the more inclined to speculate on the extension of bath architecture, because we can determine that it has practical elements. The attention of architects has been already directed to it, and our readers will recollect in our architectural exhibitions, designs which have shown interiors and features of bath architecture, well calculated to excite the interest of the professional man. There are circumstances too, connected with this class of buildings, which give them a wider scope in their application than would be at first conceived. Bathing is to some degree a summer occupation, but the wash-houses attached to these establishments are in permanent use by the women of the working classes; and there is every probability that as the washerwomen are desirous of using them for trade purposes, they will lead to the establishment of great public lavatories, in their general principle resembling those of the continent. Mr. Cape is strongly of opinion that such application will be profitable, and we think experience and the influence of circumstances are in favour of his views. The employment of the wash-houses by the working classes is however found to be attended with inconvenience to the mothers of families, who cannot be separated from their children and cannot take them into the washing compartments. At the Lambeth Baths they have a kind of temporary infant school, where the children can be left, and which is found to answer.

The hot baths are more or less used in winter, but even a tepid swimming bath has then few votaries, and a large area is therefore left unoccupied for aquatic purposes during several months. Heretofore such places have been used for casinos, public meetings, and even for prize-fights and wrestling matches, but it is easy to conceive that improved structures might be so applied during the winter season as to produce profitable returns. Thus they would be suitable to cattle shows, poultry shows, and in some cases, to vast musical promenades, the more especially if they were originally designed of an ornamental character. On the other hand, in the summer there is a greater demand for open air amusements and less for that which is offered under cover, and by judicious arrangement a bath can always be so adapted as to bring a good revenue.

While we have been descanting on the domain of art, we cannot forget that the new vocation which has been opened for architects is greatly owing to a poor woman, named Catherine Wilkinson, who during the cholera year of 1832, opened a small wash-house in a back street of Liverpool, called Frederick-street, for the purpose of enabling her neighbours to wash their clothes away from their living rooms. In this undertaking she was helped by some charitable ladies, and was thus the means of laying a practical foundation for a useful institution. In Frederick-street a public bath has since been erected, but we should have liked to be able to report that the services of Mrs. Wilkinson had been commemorated on the face of the structure, and that if the opportunity had offered she had obtained employment within its walls.

Mr. Cape necessarily devotes some space to the great model establishment in Goulston-square, which was erected and described by Mr. Baly, and he points out the true worth of this institution as an example in answer to those who have objected to its great cost. The gross expenditure was 26,632*l.*, whereas now an establishment of like capabilities can be erected for half the money; but Mr. Cape shows that this is owing to circumstances of an exceptional nature, and to its experimental character, of which, as it was intended, the public have had the benefit in the construction of similar buildings elsewhere. Without going into details, which constitute large deductions from the above gross outlay, it may be pointed out that one important object was to ascertain the most effectual and least expensive mode of heating the baths, drying clothes, and for which it was necessary to incur much expense in trying various plans; and although the system adopted was necessarily far from perfect, it became, as was intended, the model for like structures throughout the country. The money which was subscribed for such a useful purpose by the Committee, might very properly be reimbursed by the nation; but we need hardly say there is no prospect of this, though the working of the Baths and Wash-houses Act has been greatly facilitated by this benevolent and experimental undertaking.

The economical and mechanical arrangements connected with baths are matters of interest to our professional readers, and are well treated by Mr. Cape, who has a practical knowledge and shows himself observant; but we have not, after the space we have devoted to the artistic considerations, the opportunity for their proper examination. Nevertheless, they well merit the attentive study of the professional man in designing baths, and in the light they throw on many classes of edifices. The arrangement of the apartments and entrances materially affects not only the prime cost, but the yearly outlay, and architects do not always bear this in mind. Many buildings, as churches, take care of themselves, and require small annual outlay, while they admit of great architectural display; but it is not so with many classes of public buildings, and a careless or unskilled architect, while apparently economising, may really ruin the concern by entailing upon it a needless and perpetual expenditure for attendants, fittings, and repairs. Mr. Baly has well shown that it is worth 200*l.* to get rid of an attendant by a constructive expedient diminishing labour.

The influence of bath architecture has been already felt in many trades, but we consider that, on account of the restricted character of the present buildings and apartments, that scope has not been afforded for decoration which is desirable, and which will be presented in larger edifices. A railway platform scarcely admits of decoration, but a great public hall for bathing would have additional attraction in pleasing decorations, which might be economically adapted. The taste of the present day is in favour of such application, and we may yet have establishments which may prove more ornamental to the metropolis and creditable to ourselves.

*Rosso and Verde Antico.*—The quarries from whence these materials were obtained have, it is well known, been for ages quite lost sight of; but the King of Prussia, actuated by a love for the fine arts, recently commissioned M. Siegel, the sculptor, to make researches in Greece, which have been completely successful. The Rosso-antico has been found by him on the southern slope of the Taygotos range of mountains, and the Verde-antico on the north side of the island of Tinos. M. Siegel has succeeded in making these two localities, which are very small in extent, his private property. The king has given orders for several large slabs.

## ON SANITARY IMPROVEMENT.

By Southwood Smith, M.D.

For some years past there has been in the public mind a growing conviction that the physical condition of the labouring classes is mainly dependent on the state of their dwellings. The conviction has become equally strong, that whatever improvement is effected in the physical condition of the people is conducive to a corresponding elevation of their intellectual, moral, and social state.

Investigations into the sanitary condition of populous districts in general, and of the houses occupied by the industrious classes in particular, have been made partly by private individuals, and partly by commissions under the Crown. On the evidence collected under these inquiries, rarely exceeded in extent and value, the Legislature has passed a general measure called the "Public Health Act," granting to local authorities the powers requisite for constructing and maintaining permanent works of sanitary improvement, while a distinct department of government, under the name of the General Board of Health, has been created to administer this Act. Still the acceptance of the Public Health Act is permissive, not compulsory; and therefore the actual extension of sanitary improvement is wholly dependent on the state of knowledge of local authorities, and of ratepayers by whom those authorities are elected.

The evidence which formed the basis of this legislation had distinctly traced to the condition of the houses of the labouring classes, the main causes of the excessive sickness and mortality disclosed by the returns of the Registrar-General;—had distinctly traced to certain definite conditions in and about these wretched abodes the true sources of those constantly-recurring epidemics, which swept away one half of the children born while yet in childhood, destroyed by fever the heads of families in the prime of life, and deprived the whole of this class of the population of more than one-third of the natural term of existence.

But the evidence was not so apparent that this state of things is no necessary and inevitable condition of poverty. While the consequences of bad sanitary conditions were demonstrated, there were presented no very conclusive facts to prove the power of good sanitary conditions to secure to the working man and his offspring the like measure of health and life as is possessed by the wealthier classes. There was, indeed, the strongest conviction on the minds of those who had paid attention to the subject that evidence to this effect was obtainable, and they felt assured that it would be found in the result of residence in houses so constructed as to be fit for human habitation.

It was under this impression that about twelve years ago a few individuals who had taken the lead in the investigations just referred to, formed themselves into an association for the purpose of putting the truth of their conviction to the test of experiment. Their plan was to erect a large building divided into suites of apartments, capable of accommodating a number of families, and provided with the following sanitary conditions:—

1. The thorough subsoil drainage of the site.
2. The free admission of air and light to every inhabited room.
3. The abolition of the cesspool and the substitution of the water-closet, involving complete house-drainage.
4. An abundant supply of pure water.
5. Means for the immediate removal of all solid house refuse not capable of suspension in water, and of being carried off by water.

It also seemed probable that benefit would result from their example; that if it should be found practicable to offer houses well built, well drained, and well supplied with air, water, and light, at no greater charge than is obtained for houses in which no provision whatever is made or attempted, for the supply of any one of these essential requisites of health, cleanliness, and comfort, a public service would be rendered beyond the mere erection of so many better-constructed houses; and that, especially, it might help to render it no longer easy for the landlord to obtain an amount of rent for badly-built, which ought to suffice for well-built houses, and that it might thus indirectly tend to raise the general standard of accommodation and comfort for all houses of this class.

It was found, however, that to acquire the means of erecting a suitable structure for the accomplishment of this object, it would be necessary to obtain exemption from the common law of partnership, without which exemption each member of the Association would have become liable to the whole extent of his property, for all debts legally incurred in the undertaking. It was only by a Charter from the Crown, or by an Act of Parliament, that this liability could be limited to the amount of each shareholder's individual subscription.

The Charter is framed on the principle that the object not being money-getting, but philanthropic and national, the profits, after the payment of a moderate rate of interest, instead of going to increase the amount of the dividend, should be applied to the extension of the scheme. The main provisions of the Charter are—The limitation of the liability of the shareholder to the amount of his individual subscription; Power to make calls; Dividend not to exceed 5*l.* per cent per annum; Capital 100,000*l.*, 25,000*l.* of which to be subscribed before commencing works, and 10*l.* per cent. thereon paid up;* Power to increase the capital with consent of the President of the Board of Trade, and two-third parts in number and value of the shareholders present, at two general meetings especially called for that purpose.

Subsequently a Supplemental Charter was obtained, giving power to establish Branch Associations in the Provincial Districts of England and Wales, and for this purpose to raise a Provincial Capital of One Million sterling, and to apportion the same to different Provincial Districts, the shareholders of each Provincial District being interested in the profit and loss of their own shares only, separately from any other shares of the Association.

Seven years elapsed before these preliminary proceedings, the choice and purchase of the site, and the erection of the first buildings were completed, so that the buildings have been opened for residents only about five years. The Association took the name of the "Metropolitan Association for Improving the Dwellings of the Industrious Classes," and their first buildings, called the "Metropolitan Buildings," are situated in Old Pancras-road, leading from King's Cross to Camden Town.

The Metropolitan Buildings consist of 110 sets of rooms, 20 being sets of two rooms, and 90 of three rooms. Attached to each set of rooms is a scullery provided with a sink, a supply of water at high pressure at the rate of forty gallons per day, and the means of carrying off ashes and other solid refuse through a shaft accessible from the scullery. There is no cesspool on the premises. The water-closet, substituted for the privy, is situated in the scullery, the door of the closet being so hung as, when open, to shut off access to the scullery. Each living-room is furnished with a range, boiler, and oven. By an extremely small quantity of fuel the oven is capable of baking bread, cooking meat, and any other kind of food, and the boiler contains a quantity of hot water always ready for use. The ground in front of the building is enclosed by iron rails, and forms a protected space for the children of the residents, and at the back there is a wash-house, with a drying ground attached for the use of the families.

The sum expended on these buildings, amounts to 17,736*l.* 17*s.* 11*d.* The rooms, which average from 14 feet by 10 ft. 6 in. to 13 feet by 8 feet, are let from week to week, the rent of each set varies from 3*s.* 6*d.* to 6*s.* 6*d.* per week. The total rents receivable from the various establishments of the Association since December, 1847, amounts to 14,630*l.* 11*s.* 7*d.*, of which there has been actually received 14,594*l.* 6*s.* 11*d.*, leaving a deficiency from bad debts of only 36*l.* 4*s.* 8*d.* for five years.

Besides the Metropolitan Buildings in Pancras-road, the Association has erected another set of Metropolitan Buildings in Albert-street, Mile End New Town, capable of accommodating 60 families, at a cost of 10,297*l.* 4*s.* 10*d.* They have also purchased 25 houses, situated in Pelham-street and Pleasant-row, Mile End, capable of receiving about 23 families, at a cost of 5120*l.* 19*s.* 3*d.*; and they have decided on erecting another building in Bermondsey, capable of accommodating 108 families, at a probable cost of from 20,000*l.* to 25,000*l.*†

The lodgings for single men in London occupied by labourers and artizans being in general as unhealthy as the houses for families of the same class, it was conceived that the provision of fit accommodation for single lodgers fell within the legitimate province of the Association. Accordingly a lodging-house for single men was erected, capable of accommodating 234 inmates, at a cost of 13,493*l.* 13*s.* 9*d.*, and another capable of accommodating about 128 inmates, was purchased by the Society for 1422*l.* 7*s.* 7*d.*, being leasehold,* at a heavy ground-rent.

Four Branch Associations have been affiliated with the parent institution, namely, at Brighton, Dudley, Newcastle, and Ramsgate.

The experiment has proved eminently successful with reference to its great object, the protection of health and the diminution of preventible sickness and mortality.

In 1850, the total population in the Metropolitan Buildings, Old Pancras Road, was 560, and the deaths were 7, being at the rate of 12 and a half in 1000 of the living.

In 1851, the total population was 600, and the deaths were 9, being at the rate of 15 in the 1000.

In 1852, the total population was 680, and the deaths were 9, being at the rate of 13 and a fraction in the 1000. The average mortality of the three years in these buildings has been 13·6 per 1000.

But taking together the whole of the establishments of the Association, which had now come into full occupancy, the total population for the year ending March 1853, amounted to 1343. Out of this number there were, during that year, 10 deaths, being at the rate of 7 and a fraction in the 1000.

The deaths in the whole of the metropolis, during the same year (1852), reached a proportion of 22 and a fraction in the 1000; consequently, the total mortality in London generally, taking together all classes, rich and poor, was proportionally more than three times greater than the mortality in these establishments.

The Act entitled "The Labouring Classes' Lodging-houses Act," received the Royal Assent on the same day as the "Common Lodging-houses Act." The "Labouring Classes' Lodging-houses Act" is merely an enabling Act, but it gives most important powers to local authorities for raising loans, procuring lands, and building or buying houses, in order to provide more convenient and commodious dwellings for the labouring classes. Under this Act any town or district may by certain recognised authorities and under certain conditions, erect new structures or purchase' existing tenements unfit for human habitation, and replace them by wholesome dwellings; and such authorities may do this on the principle of a commercial enterprise, though the requisite capital is to be supplied from the rates. By this statute, therefore, local authorities in general are empowered to do what has been done in London by the Metropolitan Association, and the Society for Improving the Condition of the Labouring Classes. (See provisions of the "Labouring Classes' Lodging-houses Act," 14 and 15 Vic. cap. 34.)

## ORNAMENTAL GLASS SURFACES.†

ADOLPHE MARIUS ALEXANDRE IGLESIA, *Patentee*, April 9, 1853.

THIS invention consists, first, in the production of ornamental surfaces in imitation of marble, granite, or any substance capable of a similar polish, by applying, to the under surface of plates or pieces of glass, paper, or any other suitable pliable material, on which may be printed, lithographed, drawn, or coloured, by any of the well-known processes, a design, device, figure, or pattern in imitation of such marbles, granite, or other substanee. Secondly, in ornamenting the under surfaces of glass by applying thereto paper or any other pliable material, on which may be printed, lithographed, drawn, coloured, or otherwise produced by any other suitable process, a design or device which shall have the effect of designs painted upon such surface, or of mosaic or other ornamental work. Thirdly, to a method of consolidating or strengthening the pieces of glass thus ornamented, so as to give them the strength of marble or stone.

The process which the patentee employs for the first and second of the purposes aforesaid is as follows:—He dissolves in a vessel of pure water, by the employment of a water bath at a gentle heat, gelatine or common glue, or any other gelatinous substance, all of which is hereinafter called "glue." In selecting the material to be employed for this purpose he prefers such as is of a white colour, as far as it can be conveniently obtained. He does not limit himself to any particular strength of solution, but that which he prefers usually to employ is of the strength ordinarily used for the purposes of carpentry.

When the glue or gelatinous substance is entirely melted, it

* Shares to the amount of 65,150*l.*, had been taken up to the end of March, 1853.

† This building cannot be proceeded with at present for want of adequate funds, although the ground has been purchased. The Directors have also recently obtained possession of a building in course of erection in New Street, Golden Square, in the parish of St. James, which will accommodate 64 families.

* The other sums before mentioned, with the exception of the one relating to the buildings in Old Pancras Road, include the purchase of the freehold.

† Reported in the 'Repertory of Patent Inventions.'

must be strained through a sieve, so as to remove all impurities; after which it must be warmed to about 80° Fahr., when it will be fit for use. He then takes the piece of glass to which the paper or other substance having the design thereon (all of which is hereinafter called the "paper") is to be applied, and, after washing the glass well with warm water, he lays the paper upon it, with the decorated surface uppermost, and passes the solution all over it by means of a sponge; he then removes the paper from the glass, and wets the glass well with the solution, after which the paper is replaced upon the glass, with the moistened surface undermost, and the solution passed again over it with the sponge, taking care to remove any folds or creases which may show themselves. The piece of glass is then turned over, so as to place the paper underneath it, and after raising the glass with the left hand, he passes warm water over the surface of the glass with a sponge, until all the glue is completely melted. He then, by means of a piece of steel with the edge rounded, presses out the glue from between the paper and the glass; and, lastly, he turns the glass so as to place the paper uppermost, and repeats the same operation until the superfluous glue is removed; after which the back of the paper is cleaned with a sponge moistened with warm water, and it is then left to dry. The temperature of the water employed in this operation should not exceed 80° to 100° Fahr.

This process is applied to the production of patterns made of different pieces of papers of various colours by the following method: The patentee glues the separate pieces, arranged so as to form the desired pattern, design, or device, upon cloth; the design thus composed may, when dry, be fixed on the glass in the manner described above; then, upon moistening the back of the cloth, and carefully removing it, the pieces forming the design will remain and adhere to the glass.

In order to form such a pattern he also sometimes applies the paper which is to form the foundation of the pattern to the glass in one piece, and afterwards cuts out such parts as require to be removed to allow of the introduction of the design, and removes them by means of a little warm water and a brush and any blunt instrument, and fills up the vacant spaces with the paper, which must be attached by the methods before described.

The glass employed may be of any kind, care being taken to select such pieces as are not much curved and are not very brittle.

The third part of the invention, namely, the strengthening of the glass plates prepared in the manner above set forth, is effected in the following manner:—When the paper attached to the glass is quite dry, the patentee applies to the back of it a resinous composition, which is hereinafter called the "mastic," and is made of resin, plaster of Paris, grease, dry sawdust, cotton flock, or, in lieu of the last two substances, of sand. The mixture which he prefers, consists of four pounds of resin, four pounds of plaster of Paris, half a pound of grease, and three-quarters of a pound of sawdust. If it is desired to make the composition very hard, the quantity of grease may be diminished, or it may even be omitted altogether. All the substances may be put on together and melted over a slow fire, and the whole stirred up with a piece of iron until they are well mixed together.

Before applying the mastic the patentee has found it useful to cover the back of the paper with a mixture of glue and whitening, or of glue and plaster of Paris, which should be allowed to get quite dry. The use of this covering is to protect the glass from being cracked by the heat of the mastic, but, if care be taken in the application of the latter, it may be dispensed with. To prevent the danger of the front of the glass being scratched, it is covered over with a similar mixture. The mastic is applied at a temperature just sufficient to keep it melted. In applying the mastic the glass is laid upon an even surface of wood, and if the surface of the glass is not quite flat, weights of about six or eight pounds each are placed upon the edge, at a distance of two or three inches from each other, so as to flatten it; the mastic is then laid evenly with a trowel upon the paper until it is one-eighth of an inch thick, commencing from the outside, and changing the position of the weights as a part is proceeded to where the mastic is dry enough to support them, and applying it gradually, so as not to heat the glass suddenly. When the mastic is quite dry, slips of slate are taken about three inches broad and a quarter of an inch thick, and of a length regulated by the size of the glass, but not exceeding two feet, through different parts of which must be previously pierced a number of holes by means of any common borer. These holes should be larger at the side which is intended to be nearest the glass than at the bottom. The bottom surface of the slate should be slightly warmed, and then a portion of fresh mastic may be applied to that part of the previously covered surface to which it is desired to apply the slate; and the slate is then pressed down upon it, so as to force the mastic up through the holes. When, by this process, one piece of slate is attached to the mastic, another is laid alongside of it, taking care to fill up the intervals between the pieces of slate and the holes in these pieces with the mastic until the back of the glass and paper is covered entirely with mastic and slate. So soon as the mastic is cold, the glass will remain straight and solid, and the decorated surface will be perfectly preserved from injury. If a further thickness be required, it may be obtained by a repetition of the same process. In cases where lightness is required, and where the glass is not exposed to violent blows, backing is dispensed with except the mastic, which is always employed.

In applying the invention to the coating of bricks or stones with ornamented glass surfaces, the patentee does not carry the holes by which the brick or stone is attached to the mastic through the substance thereof, as in the case of slate, but only cuts them a little way into it.

The blocks or slabs, prepared as aforesaid, may be fixed in a wall or used as a flooring with ordinary cement, in the same way as ordinary blocks or slabs of marble, requiring only similar precautions to those commonly used by workers in marble to preserve them from scratches; and pieces of wood, iron, or any other solid substance may be let into the mastic, so as to give facilities for attaching the blocks or slabs.

*Claim.*—1. Ornamenting glass surfaces, as above described, with various devices, designs, or imitations of natural objects by means of paper or other suitable flexible material, on which may be printed, lithographed, drawn, or coloured, the desired device, design, pattern, or imitation; 2. The methods above described of strengthening or consolidating such ornamented surfaces, and rendering them applicable to the various purposes for which they may be employed.

## COMPOSITION FOR COATING MATERIALS EXPOSED TO THE ACTION OF SEA WATER.*

Edward Onslow Aston and George Germaine, *Patentees*, April 23, 1853.

The invention refers to mineral conpositions, prepared principally from sulphur and salts or oxides of copper, which are to be applied in a hot liquid state to metal, wood, stone, cement, and other materials; being used for wood ships, in lieu of coppering, and for iron ships instead of the usual anticorrosive paints and other ingredients employed for coating the same; and may likewise be used as a preventive of the action of the weather or sea-water generally, by coating the surfaces of the exposed materials therewith.

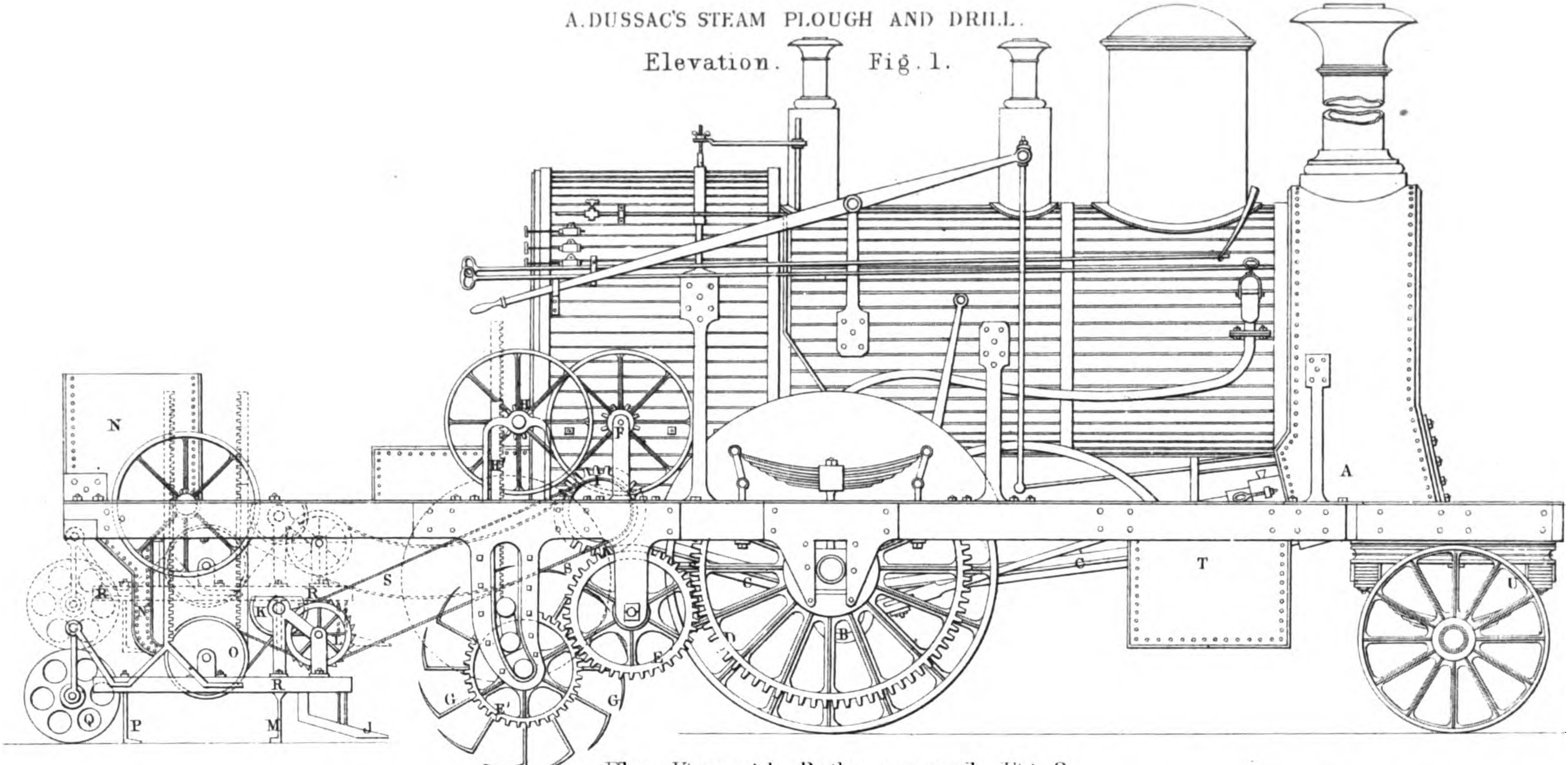
The patentees melt together, and thus combine in variable proportions, sulphur, naptha, and creosote; adding thereto verdigris or acetate of copper. Sometimes substituting for verdigris, copper pyrites, artificial sulphurets of copper, blue vitriol or sulphate of copper, and other combinations of copper with acids or oxygen, either singly or mingled, being first properly ground. The sulphur, naptha, creosote, and sulphuret, or salt or salts of copper, singly or combined, are to be heated together and well stirred, after which the composition resulting therefrom may be poured out into suitable moulds, and when cold broken up and packed in a dry hard state, ready to be remelted when wanted for use.

One of the various preparations that may be thus compounded is made by fusing in an iron pan, or any convenient vessel, three parts by weight of sulphur, and adding one part of naptha heated in a separate pan. When these materials are thoroughly incorporated, one pound of acetate of copper or verdigris is to be added to every eight pounds of the composition, and well stirred into it; after which it may be run into moulds, cooled, and stored for use. Or, the sulphur being melted, the verdigris may be added, then the naptha, and afterwards the creosote, at a boiling heat, to secure the amalgamation of the materials. The same process will apply to the adding of pyrites, they being first well pulverised, and to the salts and oxides of copper generally; all which may be used in variable proportions according to the quality required.

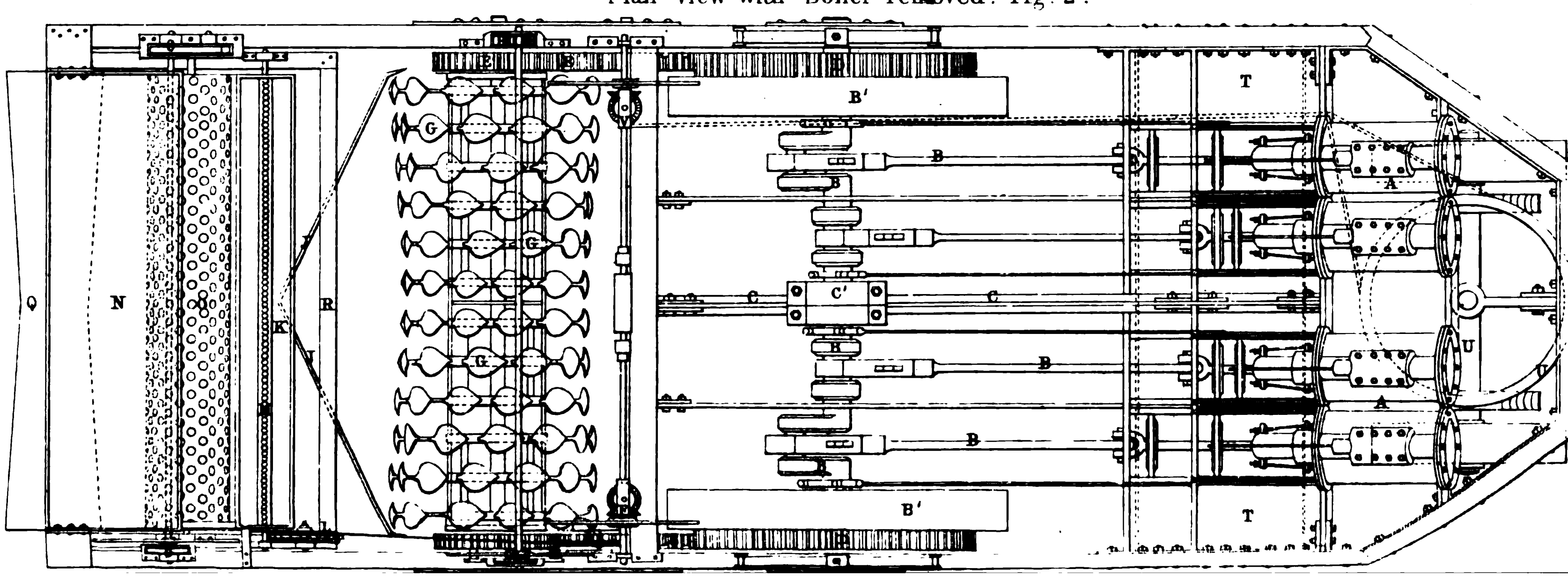
* Reported in the 'Repertory of Patent Inventions.'

A. DUSSAC'S STEAM PLOUGH AND DRILL.

Elevation. Fig. 1.




Plan View with Boiler removed. Fig. 2.



To coat iron with any of the mineral compositions, the patentees recommend the surface of the iron to be first well cleaned by scraping, and then rubbing it over with a stiff brush repeatedly dipped in hot naptha. When a sufficient surface has been thus prepared, a pot of the hot composition is to be provided and spread over the prepared iron, as customary in using pitch. When the sides and bottom of an iron vessel have thus to be prepared, the iron must be first freed from all moisture by common rubbing and firing, or in some cases simply by sanding or dusting it over with any dry ashy absorbent powder; the iron will then be ready for cleaning with the hot naptha before laying on the mineral composition.

To coat wood, and particularly wood ships' bottoms, the surface should be scraped clean, then coated with a boiling compound of naptha and creosote, preparatory to applying the mineral composition, the surface of which may be afterwards smoothed with suitable hot irons.

The mineral compounds may be applied to dry surfaces, with or without the first application of hot naptha, particularly when used for buoys, piles, and all common out-door work; and for roofs to guard them against either moisture or the attacks of insects.

For ships' bottoms, and all exposed iron or wood marine work, these compositions will be found to preserve them from the sea worm, and the adhesion of animal and vegetable products common under such circumstances, in consequence of the well-known action of the mineral poisons. The patentees do not restrict themselves to any particular proportions of the several ingredients.

## MANUFACTURE OF GLASS.*

Robert Walter Swinburne, *Patentee*, May 3, 1852.

The invention consists of a mode or modes of casting or manufacturing glass or other vitreous material in a melted state, by means of cisterns or casting vessels, which are placed in a furnace or kiln whilst being filled or charged from the melting pots, for the purpose of avoiding the diminution of the heat of the melted glass or metal before casting, which is consequent upon the ordinary mode of casting plate glass. The invention is carried into effect as follows:—Near to each melting pot in a furnace a cistern or casting vessel is placed, of such a size that, when filled, it can be conveniently removed from the furnace, and taken to the casting table. Each cistern is placed close to the melting pot from which it is to be filled or charged, in order that the melted glass or vitreous metal contained in the melting pot, or a portion of it, may be transferred without waste, by a ladle or other convenient means from the melting pot into the cistern. When the pots contained in a furnace have been charged, and the glass or vitreous material in them has been melted, and is ready for use, the patentee transfers, by means of an iron ladle or other convenient implement, from each pot, into an adjoining cistern or casting vessel (which must be previously heated in the furnace), a sufficient charge or quantity of the melted material; the cistern into which the melted material is thus transferred remaining in the furnace or kiln during the whole time that the operation of charging it is going on, and until the workmen are ready to take it to the casting table. A cistern or casting vessel being thus charged, and the casting table ready, the workmen withdraw the cistern from the furnace and take it quickly to the casting table, and cast the contents of it upon the table, and roll it into sheets or plates in the usual way, and immediately return the cistern to the furnace, and place it near to the same or some other melting pot ready to receive another charge, to be dealt with as above described.

The patentee continues to transfer the melted material from the melting pots into the casting cisterns, and to cast the same into plates or sheets of glass or vitreous material, in manner above described, until the whole charge contained in each of the melting pots in the furnace has been exhausted, after which the pots are to be refilled and heated until the contents of them are ready for casting as before.

*Claim.*—The mode or modes of casting or manufacturing glass or other vitreous material, by means of casting vessels which are placed in the same furnace with the melting pot whilst being filled in manner and for the purposes described.

* Reported in the 'Repertory of Patent Inventions.'

## STEAM PLOUGH AND DRILL.

Alexis Dussac, *Patentee*, October 17, 1853.

(*With an Engraving, Plate* XIV.)

This agricultural machine consists of an arrangement and combination of apparatus for ploughing, sowing seed, and manuring the land at one operation.

Supported on a suitable carriage is an ordinary locomotive engine, having two pairs of steam cylinders connected to the driving-wheels, which are made to revolve independent of each other, to allow of the machine being turned in any direction; each wheel is connected by cranks and connecting-rods to one pair of steam cylinders. Concentric with each driving-wheel is a large spur or toothed wheel, gearing into an intermediate spur-wheel which actuates the ploughing apparatus. The plough consists of a number of shovel-blades, attached by arms or shanks to a suitable framework. Immediately behind the plough is a follower or iron plate for levelling the surface of the earth preparatory to sowing the seed. The apparatus for sowing the seed consists of an ordinary drill, carried upon a moveable frame, capable of being raised or lowered when required. At the end of the carriage-frame of the machine there is a box or chamber for containing manure, the distribution of which is regulated by a perforated cylinder attached to the moveable framework carrying the drill. Following the manure distributor is an iron roller, which covers in the seed and manure, and smooths the surface of the furrow.

Fig. 1, Plate XIV., represents an elevation of this machine; and fig. 2 a plan of the same, with the boiler removed. A, A, represent two pairs of ordinary steam cylinders, supported on the framework of the machine, each pair connected by connecting-rods and cranks B, B, to one of the driving-wheels B′, B′. C, is an iron frame, carrying the clutch-box C′, in which the inner end of each half of the axle of the driving-wheel works; D, D, are toothed wheels, fixed concentric with the wheels B′, B′, and gearing into intermediate spur-wheels E, E, which actuate the spur-wheels E′, E′, keyed in the axle of the plough G. F, F, an ordinary contrivance of bevil wheels, cords, and rollers, for the purpose of throwing the spur-wheels E, E, into or out of gear with the wheels D, D, when requisite. H, is a small pinion, fixed on a suitable frame, and gearing into the rack H′; the lower end of the rack is attached to the axle of the plough, for the purpose of regulating the depth to which it is desired the cutters should take into the soil, or of raising the plough completely off the ground when the machine is not in action. I, is an iron follower or blade, which prepares the surface of the ground for the reception of the seed, and gives the requisite inclination to the furrow. K, is the seed-box, and L, a ratchet-wheel for shaking the box K. Motion is imparted to the ratchet-wheel L, by means of a band or cord passing over a rigger or pulley keyed on the axis of the spur-wheel L, which gears into the intermediate spur-wheel E. M, are the drills for depositing the seed. N, is a box or chamber containing manure, which falls through the hopper N′, and is uniformly distributed over the furrow by the perforated cylinder O, which is caused to rotate by a cord passing over a pulley on the axis of a ratchet-wheel L. P, is a series of tin tubes, placed in a line with the drills M, for the purpose of covering up the seed dropped by the same. Q, is a cast-iron roller, which smooths the surface of the furrow, and completes the operation of sowing the seed. R, is a wooden framework, which carries the seed-box, drills, manure distributor, and roller, &c. When not required to be in action, the framework R, is raised by the rack and pinion S, to the position indicated by dotted lines, carrying with it the whole of the apparatus attached thereto. T, is a water-tank. U, moveable guide-wheel, to which the fore-wheels of the machine are attached, to admit of their being turned in any direction when the machine is required to be removed or turned round, when arrived at the end of the furrow. This moveable guide-wheel U, is acted upon by a band or cord passing around it and connected to a roller on the axis of the bevil-wheel V. Acording to the direction in which this bevil-wheel is made to rotate, the fore-wheels are caused to rotate either to the left or right; and by this means the machine is capable of being guided with great accuracy.

## CONSUMING SMOKE AND HEATING LIQUIDS.

Samuel Bayliss, *Patentee*, April 15, 1853.

This invention relates—First, to the perfect combustion of the gases arising from the heated fuel in steam-engine and other furnaces, for the purpose of preventing smoke and economising coal; secondly, to the retaining within such furnaces much of the heat which now passes away to the chimney without producing any useful effect; and thirdly, to facilitate evaporation by causing a rapid circulation in the liquids to be heated.

In order to effect a chemical combination between the gases of combustion and the oxygen of the air, the patentee proposes to intercept or retard the gases on their way from the fireplace to the chimney, by dividing them into a number of small streams or bodies, and forcing them into mechanical admixture with the air, which is supplied in small currents.

The furnaces are fitted, in place of the ordinary fire-bridge, with an air-chamber, formed by two cast-iron plates, built in the walls or sides of the furnace, immediately under the inner end of the fire-bar, and provided with a door for regulating the admission of air to the same. One of the plates forming the air-chamber serves as a support for the fire-bars on one side, and the bearing-bars on the other; these bearing-bars are laid lengthwise across the air-chamber, with spaces between them to allow of the passage of currents of air between them. Perpendicular to these bearing-bars are fixed other bars of metal or clay, which serve as "admixers and heat-retainers," and have spaces between them for the passage of the gases of combustion, which, in their endeavour to permeate the numerous channels presented by such an array of bars, and the agitation consequent thereon, are brought into intimate mechanical mixture with the air from the chamber below; the bars also becoming red-hot, form a retainer for the heat of the furnace, and consequently a steady combustion is produced from one end of the admixers to the other. Another modification of the admixers consists in placing a cast-iron vessel on either side of the furnace, and connecting them by metal tubes, which act as admixers. One of these vessels has communication with the force-pump, and the other with the boiler, and thus all the water that enters the latter must pass through the tubular admixers, and by absorbing the heat prevent them from being burnt away, and also, by heating the supply water, greatly economise the fuel.

The second part of this invention relates to extending the admixers and heat retainers to the end of the boiler, or if desirable, through the internal tube or flue of the boiler. These being maintained at a red heat by the passing flame and heated gases, will give off, by radiation, to the surface of the boiler a great quantity of heat, which would otherwise pass up the chimney and be wasted; they will form, in fact, a continuous fire from one end of the boiler to the other, and tend to spread the heat more uniformly throughout the furnace. This arrangement is applicable to evaporating pans, such as those used in the manufacture of salt, for example, where slow combustion and uniform heat under the whole of the evaporating surface are required.

The third part of this invention consists in placing on the bottoms of boilers or evaporating pans a number of hollow cones, open at top and bottom, and supported on legs so as to leave a free passage for the liquid underneath and through them; they should be sufficiently heavy to maintain their positions by their own gravity, or they may be attached to iron bars fixed to the bottom of the boiler or pan—in this case the legs will be unnecessary. On heat being applied, it expands the liquids in the cones, and causes upward currents which carry off the particles of steam as fast as they are formed, the cooler liquid outside the cones rushes downwards to supply the place of that which is ascending, ensuring a rapid and continuous circulation and quicker diffusion of heat.

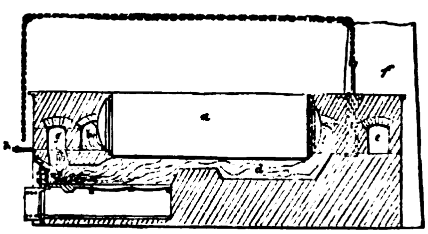
*Claims.*—1. The intercepting the gases in their transit from the fireplace to the chimney, and dividing them into a number of small streams or bodies, and bringing these in contact with a current or currents of air, in such manner as to produce an intimate mechanical mixture of air and gases, in order to facilitate their chemical union; 2. The application of admixers and heat retainers, whether employed in conjunction with the apparatus for preventing smoke, or in furnaces of any other construction; 3. The application of hollow cones, open at both ends, for facilitating evaporation, and preventing the bottom of vessels used in heating liquids from being burnt.

## CONSUMING SMOKE.*

James Bristow and Henry Attwood, *Patentees*, April 28, 1853.

This invention relates to a mode of constructing or arranging the flues of steam-boiler and other furnaces, when two or more are set side by side, or brought into connection with each other, so that the smoke or gases of combustion given off from one furnace may be conducted over the bright fire of another furnace, and be thereby consumed. This object is effected by bringing the several adjacent furnaces into communication with a common flue, provided with dampers, which will permit of a temporary connection being set up between any two furnaces in the range. Thus, when fresh fuel is thrown on to one of the furnace-fires, by diverting the course of the gases generated in that furnace, and causing them to enter the common flue (which diversion may be effected by closing the damper in the exit-flue of the smoking furnace), the smoke and gases may be conducted into a furnace having a bright fire, and be there consumed. When smoke ceases to be given off from the recently-charged fire-place, the gases of combustion are turned into their proper channel, and allowed to escape into the chimney.

Fig. 1.



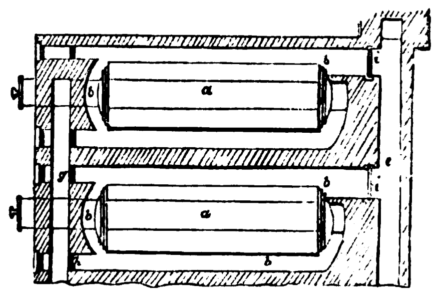


Fig. 2.

Fig. 1 of the annexed engravings represents a vertical section, and fig. 2 a sectional plan of this method. *a*, *a*, are the boilers, which are severally set in brickwork, which forms a flue *b*, around them of the ordinary kind. Into this flue the flame and heated gases from the fireplace *c*, pass, by a flue *d*, which runs under the boiler; and the gases having circulated through the flue *b*, escape into a common flue *e*, at the back of the furnaces, and finally make their exit at the chimney *f*. Immediately over the fireplace *c*, in each furnace is an opening, which leads to a flue *g*, formed in the brickwork, and running from end to end of the series of furnaces. These several openings are commanded by a sliding door or damper *h*, which, when closed, cuts off the communication between the several furnaces and the flue *g*. The flues *b*, near that end which connects with the common flue *e*, at the back of the furnaces, are likewise severally provided with a damper *i*, for cutting off the communication between their respective furnaces and the flue *e*. These dampers *i*, are each suspended by a chain *k*, which passes over carrier-pulleys, and is thereby brought to the front of the furnace, to enable the attendant to raise and lower the dampers with facility.

Supposing, now, a bright fire to be burning in, say, furnace No. 1, and a fresh charge of coals to be required in furnace No. 2, the attendant will, prior to throwing on the coals, close the damper *i*, of the latter furnace, and open the damper *h*, of both furnaces; whereby the smoke arising from the fresh charge will be diverted from its usual course towards the chimney, and thrown back to the front of the furnace. A communication being now established between the furnaces Nos. 1 and 2, the smoke will pass from the latter into the fireplace *c*, of the former

* Reported in 'Newton's London Journal.'

—which contains, as was said, a bright fire—and it will be there consumed. When smoke is no longer given off by the fire in the furnace No. 2, the damper *i*, of that furnace is to be opened; and, supposing the fire to be now burning brightly in this furnace, and a fresh supply of coals to be required for furnace No. 3, the damper *i*, of the latter furnace is to be closed, and a communication established (in like manner to that just described) between furnaces Nos. 2 and 3—the damper *h*, of furnace No. 1 being closed, to cut off the connection between that furnace and the common flue *g*. It will thus be understood that any two furnaces of a series can be connected together at pleasure, for the purpose of diverting the smoke generated in one furnace, on to the bed of bright coals in an adjacent furnace, and thereby effecting the combustion of the smoke. Instead of employing a flue, built up in the brickwork, for producing a passage of communication between the fireplaces of several furnaces, iron or other tubing, having short branch pipes leading to the several furnaces, may with advantage be used; especially when the invention is required to be applied to furnaces already constructed.

*Claim.*—They lay no claim to the principle of diverting the smoke and heated gases generated in one furnace and passing them under or over the bright fire in an adjacent furnace; but they claim the means hereinbefore described, by which any two of a series of furnaces may be readily brought into connection with each other, for the purpose of effecting the combustion of the smoke given off from the successive charges of coal supplied to such furnaces.

## TREATING SEWAGE AND MANURE.*

Thornton John Herapath, *Patentee*, March 14, 1853.

These improvements in the treating of sewage consist in causing the phosphoric acid and ammonia of such matters to be precipitated in a comparatively insoluble state, by the addition of magnesia, or a magnesian compound, at or about the same time that the deodorisation of the sewage is effected by the addition of some deodorising chemical agent, which will not decompose ammonia or its salts.

In carrying out this invention, the patentee runs the matters into a tank or reservoir, and adds to them chloride of magnesium, nitrate, or sulphate of magnesia, or burnt and slacked magnesian limestone, commonly called dolomite, or a mixture of carbonate of magnesia and carbonate of lime, which will slack together. He adds, either before, after, or about the same time, such deodorising agent as may be added without decomposing ammonia or its salts, but will combine with or absorb hydrosulphuric acid, such as metallic sulphates or metallic chlorides, or animal or vegetable carbon. Upon such additions the sewage matters lose their offensive smell, and their fertilising parts precipitate to the bottom. The supernatent clear fluid is allowed to flow off, and either to irrigate the adjacent land or to run to waste. The pulpy sedimentary matters are now dried, either by the admixture of some material capable of absorbing water (such as sawdust, malt combings, ground bones, or coprolites, and so forth), or they are dried by artificial heat of moderate degree; when these matters form a manure of great fertilising power for use, either by themselves or by admixture with other suitable manures.

*Claim.*—The combined employment of magnesia and its compounds, together with deodorants, to sewage matters, so as to precipitate their useful parts, deodorise them, render them readily portable, and manufacture them into manure, in the manner hereinbefore described.

## ROADS AND FLOORS.*

Sir John Scott Lillie, *Patentee*, November 27, 1853.

This invention consists in the formation of blocks and slabs for the construction of roads, footways, and other like surfaces of broken stone, gravel, wood, iron, metallic substances, or other hard material, conjointly or separately, which substances are caused to adhere by means of bituminous compounds or other cements. The moulds may be formed of sand or of iron boxes with moveable sides and ends, and of any convenient size or shape (such as that of a paralellogram), two feet by one, and six inches deep. The moulds are filled indiscriminately with the said materials, or with alternate rows of wooden blocks, with the grain of the wood set perpendicularly, and the intervals filled with the before-mentioned materials cemented together. Metallic sand, borings, filings, or other small pieces of metal, may be added to any ordinary cement or bituminous compound for coating the surfaces of the blocks and slabs, which may be cast with grooves.

For heavy traffic, wooden planks from one to two inches thick should be attached to the bottom of the blocks, on which the small wooden blocks, when used, should rest; and short pieces of wood, imbedded in a concrete or other foundation, to serve as an additional support to the ends and sides of the said large blocks. For footways, floors, and other like surfaces, slabs are formed from one to two inches deep of the same combination of materials, and when great strength is required, they are attached to boards of about one inch in thickness.

*Claims.*—1. The formation of blocks and slabs for constructing roads, floors, footways, and other similar surfaces, as hereinbefore described; 2. Covering the said or other paving blocks with metallic sand, borings, filings, or other small pieces of metal, as hereinbefore described; 3. The application of boards or planks for supporting the said blocks, and also blocks of stone in ordinary use for paving purposes, as hereinbefore described.

* Reported in 'Newton's London Journal.'

## ON DIPPING AND APPARENT LIGHTS.

By Thomas Stevenson, C.E.

The author, at a recent meeting of the Royal Scottish Society of Arts, alluded to the great and well-known difficulties and expense, and, in some cases, the impossibility of constructing lighthouses upon sunken rocks. To remedy such difficulties, he proposed two methods, termed Dipping and Apparent Lights, in order to make lighthouses on the shore answer the same ends as if they were placed on the isolated rocks at sea.

Mr. Stevenson described the plan of *dipping* lights as being applicable to cases where the rocks or shoals, whose position required to be indicated, were surrounded with sufficient sea-room to enable vessels to pass to and fro without approaching near to the rocks themselves. The dipping light, instead of throwing its beam of parallel rays to the horizon in the same manner as ordinary lights, throws it downward at some given angle of depression to suit the distance of the rocks from the shore, so that whenever a vessel crosses the margin of safety, the dipping light is seen, and she has ample time to change her course.

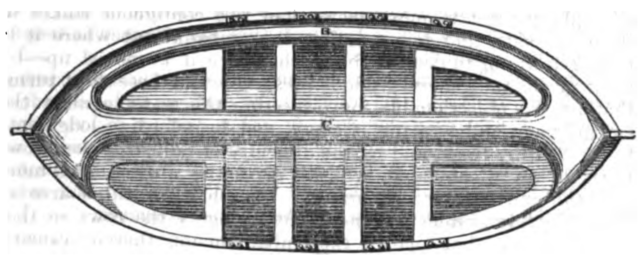
The *apparent* light is useful for sunk rocks in narrow sounds where the fairway is not broad, and where the dangers must be passed very closely; also for pier-heads at the mouths of artificial harbours, and such like situations. The apparent light at the entrance to Stornaway Bay, in the Hebrides, is erected on a sunk rock distant about 630 feet from the lighthouse on the shore, and consists of a hermetically sealed lantern, containing certain forms of optical apparatus, upon which a beam of light is thrown from the lighthouse ashore. The effect of this apparatus is to re-assemble the rays in a focus, from which they again diverge, presenting to vessels entering the bay the appearance of a real light on the beacon, when in fact there is none. So dangerous was this sunken rock, that many thought the lighthouse should be built upon it, instead of on the shore. By means of the apparent light, however, every end has been gained that could have been secured by the lighthouse, while the great expense of construction and of after-maintenance has been saved. From the very small power which is used at Stornaway (a Holofshotral apparatus of only 20 inches diameter, with a burner 1 inch in diameter) the author concludes that such a plan could be applied to very much greater distances. The optical power at Stornaway could, were it necessary, be increased about a hundredfold, if fitted with a Holofshotral apparatus of the first order. If the electric light were employed in connection with such powerful apparatus, the limits of visibility would of course be still further extended. The apparatus necessary for illuminating floating buoys on the same principle was also explained, and the paper was concluded with extracts from letters from ten different shipmasters, who certified to the utility of the beacon light *in all weathers*. The distances to which it had been seen varied from *one to one and a-half* mile,—distances greatly beyond the wants of the locality.

## SELF-RIGHTING LIFE-BOAT.

**William Barrington, *Patentee*, March 7, 1853.**

This invention is intended to supply to boats or vessels, when upset, the means of speedily righting themselves, by constructing them with buoyant chambers or materials unequally distributed, so that one side shall be more buoyant than the other; and also of affording to such boats the means of discharging the water which remains in them after righting, or that may be shipped in other ways, by fitting them with self-acting valves which open outwards.

Fig. 1.



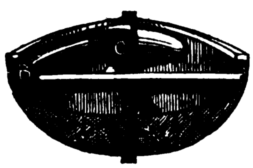


Fig. 2.

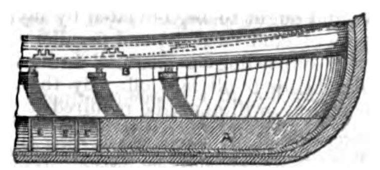


Fig. 3.

Fig. 1 of the annexed engravings represents a plan of a life-boat constructed on these principles; fig. 2 a transverse section, and fig. 3 a longitudinal section of the same. A, is a hollow or buoyant chamber or lining of cork, or other suitable light material, underneath the floor of the boat; it is raised a little at each side, as shown in fig. 3, to facilitate the passage of the water to the valves below. B, is another similar chamber or lining, placed along the top of that side of the boat intended to be made the more buoyant. C, is a third chamber consisting of a mass of buoyant material, extending from end to end of the boat, but placed a little out of the centre towards the more buoyant side; the ends of the boat may also be supplied with similar chambers. The inequality of weight thus produced is counterbalanced when the boat is in an upright position by a weight D, or ballast fixed at the bottom or attached outside to the keel; this weight also operates in righting the boat when upset. The quantity of buoyant matter thus distributed may be varied, as also the mode of its distribution, so long as it is arranged or disposed so as to give a sufficient excess of buoyancy to one side, and to render the boat capable of floating, under all circumstances, with the number of people she is intended to carry. E, E, are self-acting valves, fitted within the tubes or passages *f*, which have a protecting grating G, G, at the upper and lower ends. These valves are fixed on a pivot *e*, open outwards, and are adapted in number and capacity to the dimensions of the boat.

On reference to fig. 3, it will be seen that when the boat is upset, the weight D, acts downward in one direction, whilst the extra buoyant side of the boat B, C, is pressed upwards by the water in the opposite direction; the boat therefore is caused to revolve on the centre of gravity until she becomes restored to her natural position. The valves E, E, are kept closed while the boat is floating by the upward pressure of the external water, but on it becoming filled, or partially so, a downward pressure is produced, and the water contained in the boat forces its way through the valves. The sides of the boat are supplied all round with short rope ladders, to enable people more easily to get into her from the water.

*Claims.*—1. The unequal distribution of the buoyant chambers or materials, so as to act in the manner described; 2. The self-acting valves and their appurtenances in their general features, as constituting means of discharging water from the inside of the boat.

## IRON SUBMARINE TUNNELS.

**Auguste Edward Loradoux Belford, *Patentee*, June 30, 1853.**

This invention relates to the construction of tunnels or ways, having one or more avenues of cast-iron in sections, to be lowered into a bed prepared for them, by excavating the bottom of the river, harbour, or other water, under which the tunnel or way is to pass; the sections to be fastened together when in their bed and suitably weighted; and when all united so as to make the tunnel or way complete, to be pumped out or otherwise relieved of the water within. The improvements consist in the manner of constructing the sections, and in the manner of lowering and uniting them.

Fig. 1 represents a transverse elevation and section of a tunnel, with two main avenues for railways or roads for ordinary vehicles, and an intermediate passage for foot passengers; the elevation being on the left, and the section on the right of the vertical line A, A.

Fig. 2 is a longitudinal section of part of the same tunnel, taken in the centre of one of the main avenues looking towards the central passage.

Fig. 3 is a section of the bottom joint between two sections of the tunnel.

Fig. 4 is a section of the bed-plate, showing the guide-butts on the bottom.

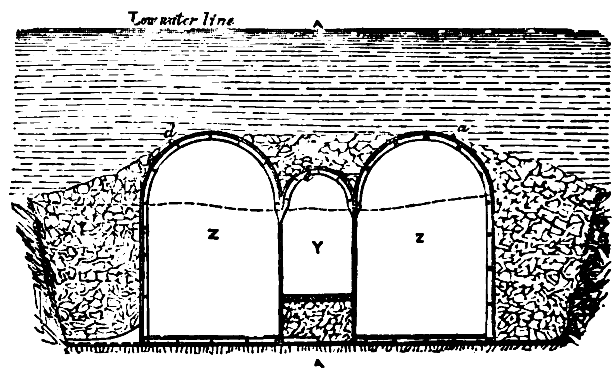



Fig. 1.

Similar letters of reference indicate corresponding parts in the several figures. The sections of the tunnel, are made of such length as is considered advisable, and are furnished with an internal flange *b*, all round, to receive the bolts by which they are secured together. A tongue *c*, is formed all round the outer face of the flange at one end of each section, to enter a recess *e*, in the flange of the next section; the said tongue and recess being packed with a strip *f*, of india-rubber. On the top of each section, two projecting ribs *d*, *d*, are cast, to form a continuous railway when the sections are put together, and it is provided with two grip-pieces for lowering it.

Fig. 2.

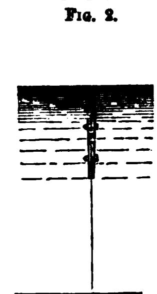
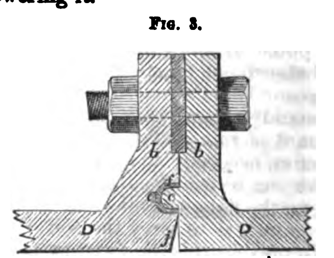


Fig. 3.



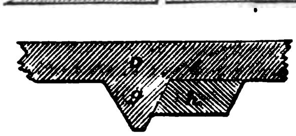


Fig. 4.

The bottom of the river or other water is excavated previous to the sinking of the sections in such a manner as to form a suitable level bed for the sections to rest upon, and to such a depth as to bring the top of the sections to a desirable distance below the low-water line. The line of excavation is marked in fig. 1, where the natural bottom of the river is shown by the dotted line. The first section, or more than one section, may be lowered by any suitable means, either on shore or afloat, and the ribs *d, d*, form a railway for a travelling derrick, by which the other sections may be lowered. The sections are lowered one by one, and bolted together by a diver with submarine armour; the india-rubber packing *f*, being inserted in the recess *e*, previous to lowering. The several sections are caused to come into their proper places, in relation to those previously lowered, by two guide-pieces *g*, of which one is shown in fig. 4 of the form of the letter V, cast on one end of the bottom of each section, and by two butts *h*, which project from the bottom of the next section; the butts *h*, being on the outermost end of the section already lowered, and the pieces *g*, on the innermost end of the section being lowered. When the section is lowered close to the end of that already on its bed, it may be dropped at once into its place. The bed-plate D, is extended beyond the sides of the tunnel to a considerable width, and strengthened by wings to receive a quantity of rubble, for the purpose of keeping the structure sunk when the water is extracted. The inside of the central passage is also filled to a considerable height, and its top covered with rubble, for a similar purpose; the top of the rubble being finished off with rubble and concrete. When the sections are bolted together, and connected with suitable shafts or inclined planes at the ends, and properly weighted down, the water is extracted, and the flanges are all packed from the inside with lead or other metal packing, as shown in fig. 3. The bed upon which the structure rests may be made with gravel, or prepared in any way that may be considered most suitable; and in order to prevent the gravel or earth being scraped up between the joints of the flanges, it is better to bevil off the lower edge of one face, as shown at *j*, in fig. 3.

*Claim.*—The manner herein described of forming submarine or subaqueous tunnels and passages in sections of cast-iron, lowered one by one into a suitable bed, excavated in the bottom of the river, harbour, or other water, and so constructed that those which are lowered form a railway for a travelling derrick to lower the others, and that those being lowered will always drop into proper positions in relation to those which are already in place, and that the whole structure can be properly weighted down.

## AMERICAN HILL-SIDE DITCHING.

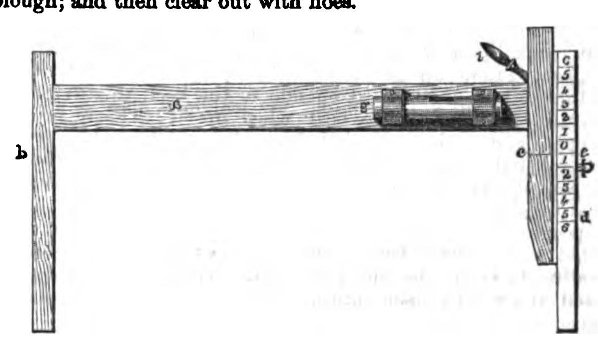
By James H. Forman.

Our soils consist of humus, clay, and sand, the clay generally preponderating. Our subsoil is a fine close clay, which resists the action of water, but when saturated retains it with great tenacity. Humus absorbs water in large quantities, and rapidly; clay pulverised in less quantities, and more slowly; sand in still less quantity, but rapidly. Hence, our soils are well adapted to absorb and retain water; and, wherever there is not a sufficiency of clay for the purpose, the subsoil may be made to furnish th necessary quantity. An ordinary shower gives about half an inch in depth of rain; a hard shower, about 1 inch; and a hard day's rain, about 2 inches. The average annual fall of rain is computed at 45 inches. Our soil, well broken and pulverised, will absorb one fourth of its bulk of water. Hence, if we could keep our land thoroughly pulverised to the depth of 8 or 9 inches, it would seldom wash, always absorbing any but an unusual amount of rain as fast as it falls; but, as this is impracticable, it becomes necessary to adopt some plan by which the unabsorbed water can be conveyed off, so that it shall not settle upon and drown the flats, or collect in such quantities while on its way to the branch as to carry the soil with it.

To prevent this, that system of surface draining called hill-side ditching has been applied; and, although it has in many instances been condemned as worthless, yet we believe that it is the only practical remedy; and we further believe that the cause of every failure has been attributable either to defective location or construction, or neglected repair. We are confirmed in this belief by observing many applications of the system eminently successful. We therefore recommend that these drains should never be more than 250 or 300 yards long without an outlet; and also to increase their capacity, either in dimensions or grade, to accommodate the accumulation of water. Where the subsoil is firm and tenacious, we recommend the latter, and submit a formula, viz: Let the first 50 yards of your ditch (counting from the summit) have a grade of ¼-inch to the yard; the second 50 yards, ½-inch; and so on, increasing the grade ¼-inch every 50 yards. In constructing the ditch thus located, the subsoil should be excavated 3 or 4 inches. This gives a channel for the escape of ordinary showers without wearing away the embankments, and also furnishes material for strengthening said embankments; but where the subsoil is light and porous, the increase of capacity must be in width. In adhesive soils the ditches may be 60 or 70 yards apart; but in light soils, not more than 40 or 50 yards.

In locating, use the spirit-level, as it is obvious that a defect in this operation is incurable. For the description and manner of using a convenient and cheap instrument of this sort, we refer you to the drawing. The inequalities of surface incidental to cultivated land will exhibit a great many abrupt turns in your location; and moving it a little, either up or down, always remembering not to move more than two contiguous stakes to the same side, and to strengthen the embankment where it is moved down, or to deepen the ditch where it is moved up—by these means the general grade is preserved; and these short turns, that are so objectionable, by projecting the water against the embankment and wearing it away, and by affording lodgments to the floating trash, and by the difficulty of adjusting your rows to them, are all obviated, while it gives the work a much more graceful and regular appearance. Another fruitful source of failure in this system is suffered by laying of the rows so that they cross or abut against the embankments, thereby causing them to be trodden down by the horse in ploughing. This may be, and ought to be, obviated by laying off the first row in each space of land close to, and parallel with, the embankments, and every succeeding one parallel to it, until your space to the next ditch below is all laid off. By this arrangement, the horse, in ploughing, will never be required to step on or over the embankment, and your rows will be as well, if not better, situated to facilitate the process of cultivation and draining than by any other means.

We are confident, from observation and experience, that the plan here indicated, if properly executed, will succeed with a very little attention, after construction, as the ditches will keep themselves clean. It will only be necessary to clear them of such rocks, limbs, or large trash, as cannot float off. We are also satisfied, from experience, that the alluvium deposited by these ditches is an effectual reclaimer of our barren glades, and by directing them to such points, the land thus reclaimed will more than compensate for that occupied by the ditches. An expeditious way to make these drains is to open your way with a turning plough, and follow with coulters; and again with a turning plough; and then clear out with hoes.




The above sketch represents an instrument used for locating hill-side ditches. *a*, is a lath, 1 inch by 4 inches, and 12 feet long. *b*, the hinder leg, 1½ or 2 inches square, 3 feet long, and securely fastened to the lath. *c*, the fore leg, 1½ or 2 inches square, 2½ feet long, and securely fastened to the opposite end of the lath. *d*, the sliding leg, 1½ or 2 inches square, and 3 feet long; it is graduated and numbered from zero, 6 inches up and down, and by means of a slit and the thumb screw *e*, may be moved and secured to any required grade, there being a mark on the fore leg that coincides with the zero mark on the sliding leg, when the instrument is adjusted to a level. *f*, a handle, to carry and hold the instrument by. *g*, a small spirit-level, securely fastened to the lath by two screws.

In using the instrument let the operator provide himself with a number of small stakes, 8 or 10 inches long, and an assistant (a small boy will do) to carry the hinder end. Then let him determine his starting point and put down a stake, directing his assistant to place the hinder leg against it; then let him determine the grade he wishes to run, and whether up or down, and adjust the instrument accordingly; then move the fore leg to the right or left until the bubble indicates a level, and put down another stake against the foot of the sliding leg, and proceed as before, directing his assistant to place the hinder foot in the precise spot occupied by the fore one. It will be seen that the instrument can be adjusted to any change of grade that may be required, in a few seconds.

## RECENT AMERICAN PATENTS.

[Reported in the Journal of the Franklin Institute.]

*Coating Sheets of Metal.* E. Morewood and G. Rogers.

This improved apparatus consists of a metallic vessel, having a flange round its top to give it the requisite strength; this vessel should be made of wrought-iron, and of a length somewhat greater than the longest sheets to be coated, and of such a depth that these sheets can be immersed in the bath of molten metal, at least eight or ten inches, when standing on edge.

*Claim.*—The method herein described of coating sheets of metal, by immersing them in other molten metals which are more fusible, by means of rollers; so that with the same machine sheets of metal varying in thickness may be coated, free from puckers, bends, or indentations on their surfaces; thus rendering unnecessary the subsequent operation of flattening, which heretofore could not be dispensed with.

*Improvements in Generating and Condensing Steam.* P. H. Watson.

*Claim.*—The method of recovering the heat of the exhaust steam by passing it through the comparatively cool water in the lower portion of the boiler; also the arrangement of the upper end of the drop-flues in an inclined plate, to facilitate the entrance of the smoke into the flues, and the passage of the steam from beneath the inclined plate into the upper part of the boiler.

*Power-Looms.* J. Greenhalgh, jun.

*Claims.*—1. Suspending each leaf of harness from two jacks, which are of similar form and length, and are geared together by toothed sectors, for the purpose of preserving an uniformity of motion to both ends of the harness; 2. Attaching the knife to the levers, and applying springs to the same, in such a way that it will move on the levers in its descent in closing the shed sufficiently to pass the points of those hooks of the ascending portion of the harness which are in a position to be raised to make the succeeding shed; and after passing the points of the hooks, will slip under them; 3. Suspending the heddle frames or the top rails by means of sheet or hoop iron links, which are pivoted to the jacks, and are furnished with pins to enter slots or notches in the ends of the top rails, by which a simple means of attachment and detachment is obtained.

*Hydraulic Ram.* J. C. Strode.

*Claim.*—The application of the brachystochrone curve to the conduit-pipes of hydraulic rams.

*Burglar Alarms.* E. Brown.

*Claim.*—The inventor does not claim the combination of an alarm-clock with a lamp-lighting apparatus, they being so applied, that on an alarm being sounded by the clock-works, they shall set free the separate machinery by which the lamp and friction match are rotated, the latter being carried against a roughened surface for the purpose of igniting it. In this alarm-apparatus, the spring which moves the match-holder not only performs the operation of moving such match-holder, but elevates the bell and its spring until the slide is brought up against the shelf, which taking place, the accumulated force on the bell causes the bell to vibrate and sound the alarm. The improvement is claimed of so connecting the match-holder and the bell-spring with the slide, that the spring of the slide, on being set free by the opening of the door, shall not only elevate the match-holder, but set the bell in motion, so as to cause the alarm to be sounded by it.

*Improvement in Fluid Meters.* W. B. Leonard.

*Claim.*—The combination in fluid meters of mechanism for measuring the volume of a flowing fluid, however variable; mechanism for measuring the velocity of the flowing fluid, however that may vary; mechanism for multiplying these two quantities together; and mechanism for recording the product in such manner as to show on a register the quantity of fluid that has passed. Also, the combination of a self-acting guard-valve or valves, however constructed or arranged, with the water-wheel or other motor in a meter, in such manner that the flow of water through the meter will be arrested whenever the pressure is not sufficient to give motion to the motor the instant it begins to flow, whereby the escape of water through the meter unmeasured is prevented.

*Improvement in Machines for Straightening and Curving Rails.* G. Williston.

This invention consists in placing over the part of the rail which is bent (by the weight of the train in passing) a curved beam, which has its bearings on the rail near the end of the beam; then, by a contrivance which embraces the rail, a screw is turned, which has power sufficient to raise the bent portion to its original position, where it may be secured.

*Claim.*—The combination of the screw, strap, beam, and slides with the beam placed on the top or side of the rail, for the purpose of straightening or curving rails on railroads, without the necessity of removing the same from the sleepers.

*Machine for Turning or Cutting Irregular Forms.* N. Gear.

This invention consists in making the cutter-heads one or both guides or gauges for the setting of cutting edges of the knives therein, and also guides or gauges to the pattern of the thing to be cut. Also, in the peculiar manner of securing the cutters into the cutter-heads by dovetails, thus avoiding the use of keys, wedges, screws, or any other device than the shape of the ends of the knives and grooves into which they fit.

*Claim.*—The combination of knives with a rotary cutter-head, so that said head shall serve as a guide or directrix to the form or pattern carrying the material to be dressed.

*Blow-Pipes for Enlarging Blasting Cavities.* A. Stickney.

*Claim.*—The inventor does not claim the enlarging a drill-hole by the use of heat or a blast of air thrown upon charcoal or other fuel in a state of combustion; but a process of enlarging the drill-hole by means of an air-blast and charcoal, or other combustible fuel, placed in the hole; the same consisting in the employment of a blast-tube made with lateral projections, and a closed or nearly closed bottom, the same enlarging the hole with a greater saving of labour and time.

*Compound Blow-Pipes for Enlarging Blasting Cavities.* A. Stickney.

*Claim.*—The instrument for enlarging the drill-hole by the employment of gas; and the combination of the two jet-chambers, the perforations or orifices, and supply-tubes, and for commingling the gases and disseminating the flame therefrom entirely round and against the sides of the drill-hole, whereby the enlargement of it into a suitable charge-chamber may be speedily effected. No claim is laid to the use of a blast of air or gas in connection with coal or fuel, and for the purpose of supplying such with oxygen.

*Steam Generators.* A. Shawk.

A tubular generator which has a forced circulation, and which, while it lines the fire-box and is expanded in its diameter from above the fire-box to its termination, is connected to a steam-chamber or receiver outside of or exterior to it.

*Method of Veneering.* C. B. Burnap.

*Claim.*—The method of pressing veneers on to the surface to which they are to be glued or cemented, by means of a fluid hot or cold acting on an interposed flexible substance, such as an india-rubber cloth or its equivalent, which will adapt itself to the surfaces.

*Making Chains.* C. Sleppy.

*Claim.*—The forging and making chains out of a solid bar without the welding process, and which is done instantly as the bar passes between four rollers, with dies on the edges of the same, moulding the links into form, and which may be done out of iron, brass, or any substance suitable to be used as a chain, from the size of a cable to a watch-guard.

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*Annealing Hollow Ironware.* D. Stuart.

Iron hollow ware is covered inside with a paste made of a composition to exclude the air, and which resists the influence of the heat; when the hollow ware is properly prepared in this manner, it is placed in the oven, and heated to a cherry-red, whereby the chill is taken out of the surface, and rendered so soft that it can be turned bright in a turning-lathe, or otherwise, preparatory to tinning.

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*Railroad Switches.* J. M. Dick.

*Claim.*—The construction of the sliding-bar, to which the ends of the switch rails are attached, with the depending flanges or side plates, which inclose the slide and cross-piece upon which it works, and afford a certain and effective protection against gravel, dirt, snow, sleet, ice, and other foreign substances, which might otherwise enter between them and derange the operation of the switch.

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*Ships' Blocks.* C. H. Platt.

*Claim.*—The employment or use of the rods passing through the cheeks, in a direction transversely of their fibre, for the purpose of preventing the splitting of the cheeks; the said rods also securing the plates to the cheeks, and forming a staple for the hook. Also the rods placed underneath the ends of the shaft, for the purpose of preventing the wearing of the cheeks, and thereby forming durable bearings for the shaft.

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*Hillside Ploughs.* N. Harrison and J. W. H. Metcalfe.

*Claim.*—Curving downward and inward the beam in the rear part, so as to cause it to support the rotary part of the plough, which it performs in combination with the standard.

The entire plough is of wrought-iron, except the mould-board, which is cast.

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*Treating Metals while in the Molten State.* H. W. Woodruff.

*Claim.*—Treating metals while in the molten state, to expel impurities therefrom, by immersing therein some porous or cellular non-conducting substance or substances containing liquid matter.

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*Clamp for Laying Floors.* S. E. Parrish.

*Claim.*—The use of the brace having clawed or forked ends, for acting at opposite sides of a beam, in combination with a screw working at right angles to the same.

A brace is made, having a clawed or forked end, with shoulder-pieces attached to the under side thereof, so as to straddle one of the flooring-beams, in combination with a screw working at right angles to the brace, and having on it a ratchet-wheel and lever and pauls for working up the screw against the edge of the plank.

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*Wheels.* Z. H. Mann.

*Claim.*—The construction of a cast-iron railroad car and locomotive wheel, whose web or portion connecting the hub and rim consists at the hub of broad radiating plates in the plane of the axis; whence turning alternately to the right and to the left, they contract in the direction parallel with the axis, and expand proportionally in the direction of revolution; those of each alternate set uniting as they approach their respective margins of the rim concave, so as to form flanges, having openings left for each intermediate plate on the other side, forming a braced and counter-braced wheel, possessing the requisite lateral stability and continued support at the rim, together with adequate provision for the strain arising from shrinkage, &c. This is claimed whether the said web be formed in a cyma reversa curve, or in any way substantially equivalent.

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*Throttle-Valve Arrangement.* J. E. Anderson.

*Claim.*—The combination, to serve the purpose of a throttle-valve or regulator, of two hollow cylindrical valves, connected with a lever on opposite sides of its fulcrum, and having slotted openings corresponding with similar openings in the cylindrical valve-seats.

The simplest way of constructing the valve-seat is to cast the cylinders with a short length of pipe, which will constitute a valve-box. The only fitting-up required will then be the boring of the cylinders, and the turning of the valve to fit them. The slots may be so narrow that they would close and open to their full width with the smallest desired amount of motion. On account of the small amount of motion that is necessary, the wear of the valves will be very slight. If slots are made on opposite sides of the valves and cylinders, they will be perfectly balanced in all directions, one balancing the other, and the steam acting equally on all sides of each; thus the friction on every part of the wearing surface will be the same, and the movement being the same, the wear will be equal.

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*Files and Rasps.* H. Powers.

*Claim.*—The forming of perforations or throats to the cutting edges of files or rasps for allowing the particles cut away to pass through, and to prevent the instrument from clogging or choking.

The invention consists in forming perforations or throats to the fin, feather, or cutting surfaces of rasps or files, for the purpose of allowing the said rasps or files to clear themselves of the material cut away by them, and to prevent their filling or choking, by admitting or allowing the particles to pass through said perforations or throats.

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*Propellers.* C. T. P. Ware.

*Claim.*—A propeller having one or more blades, the front and rear edges of which are of unequal stiffness; the blade or blades thus constructed being arranged upon an oscillatory shaft.

The blades are constructed of india-rubber, in any of its various forms of preparation, or of any other elastic or pliant material, in combination with elastic ribs or with inflexible parts.

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*Camphine Lamps.* J. Newell.

*Claims.*—1. The silvering of the perforated metal, or brass, copper, or iron wire gauze used in safety lamps and cans or other vessels, designed to prevent explosions from the vapour of camphine, burning fluid, &c., the silvering being applied for the purpose of preventing the corrosion of the metal or wire gauze by the most economical process; 2. The introduction of perforations in the caps of lamps used for burning camphine, burning fluid, &c., so small as not to admit the communication of flame through them for the purpose of allowing the escape of the vapour formed within the lamp, from camphine, burning fluids, &c., and thereby preventing the bursting of the lamps by the pressure of the vapour. Does not claim the use of any perforations in lamps for burning camphine, burning fluid, &c., except such as are constructed so as to prevent the passage of flame on the principle of Sir Humphrey Davy, relative to the passage of flame through perforated metal.

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*Ploughs.* C. R. Brinckerhoof.

*Claims.*—1. Combining with the plough-beam, between the plough and the clevis, two wheels, one on each side of the beam, and of different diameters, the one resting on the furrow and the other on the land; 2. Making the tread of the furrow-wheel narrow; 3. Making the said wheels, especially the furrow-wheel, adjustable in the direction of its axis, for the purpose of adapting its position to furrows of different widths; 4. Making the furrow-wheel beviling outward on the side which presses against the land; 5. Making the small wheel adjustable vertically with reference to the shaft and the large wheel.

The invention consists in attaching to any common plough two wheels of different sizes and shapes, the small one to run upon the land, and the large one to run in the bottom of the furrow with its side against the land, by a moveable iron axle passing through holes in the bottom part of two common cast-iron lifters or supporters, which are attached to the beam, one on each side, which have the effect of holding the plough perfectly steady, and regulating both the depth and width of the furrow-slice.

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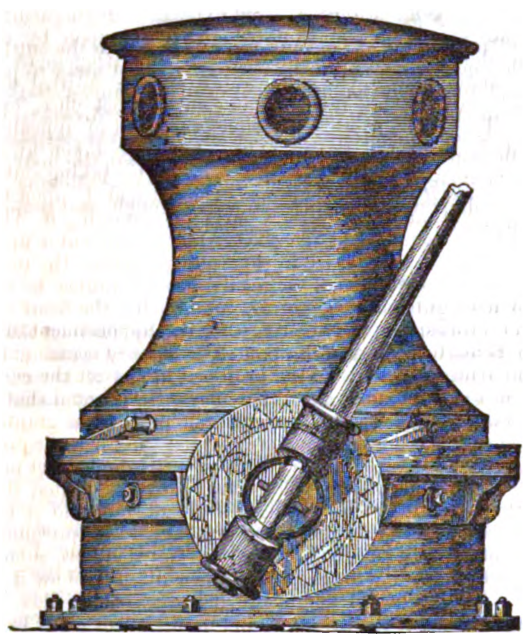
*Air-Engines.* J. A. Woodbury.

*Claim.*—Supplying the air-pump from a receiver into which air has been condensed by a hand-pump, auxiliary engine, or otherwise (the hand-pump or auxiliary engine being used for the purpose of charging and sustaining a uniform pressure in the receiver from which the air-pump is supplied), when the same is done in combination with a second receiver, into which the air is to be still more compressed and maintained at a uniform pressure, or nearly so, by the application of heat to the air on its passage to the working cylinder.

*Ash-Pans for Locomotive Engines.* G. Davis.

*Claim.*—The taking in of air in front of the ash-pan, and introducing it into the fire-box in a direction opposite to the furnace-doors, to protect the fireman from the back-lash of the fire when the said doors are open.

## PERLEY'S PATENT CAPSTAN.*



The improved capstan, of which the above cut represents a general view, has been for some time in very extensive use in the United States of America, but has only recently been introduced into this country. The action is extremely simple, and is rendered sufficiently clear by the above cut, without a detailed description of its construction. The various parts are so arranged as to cause a small amount of friction, not to present any difficulties whatever in practice, and to prevent any injury which might arise from water gathering to the working parts.

The inconveniences of the old form of capstans are too well known to require enumeration. Perley's patent capstan, instead of requiring a large space for the men to "walk" round it, may be placed in any convenient corner. It takes little more room than a ship's-pump. It is, in fact, a powerful and very convenient vertical windlass, worked by pump-handle levers, a more effective mode, as any mechanic knows, than the horizontal working of the common capstan. The capstan may be worked in either direction, by merely reversing the ratchets, and, if required, by the old mode of horizontal levers. It is said, that during the last three years, 475 of these capstans, being about one for every two days, have been sold in the United States, and almost all the vessels sailing from New York to London have one or more of them on board. Certificates signed by the United States navy constructor at Brooklyn, by several eminent ship-builders of New York, Boston, and Portsmouth (U.S.), and by the captains of several well-known vessels, speak in high terms of this capstan, as enabling the men to exert their power to better advantage than any other with which they are acquainted.

* From the 'Journal of the Society of Arts.'

## REVIEWS.

*Report of Commissioner of American Patents for the Year* 1852. Part I., *Arts and Manufactures.* Washington. 1853.

*Financial Transactions.*—The total amounts of receipts and expenditures of the American Patent Office, independent of the moneys refunded on withdrawals and those paid by mistake, were, for the years 1851 and 1852, as follows:—

| | | | |
|---|---|---|---|
| Receipts in 1851 ...... | $81,160 72 | Receipts in 1852 ...... | $90,671 35 |
| Expenditures............ | 72,339 04 | Expenditures ......... | 74,531 92 |
| Surplus ......... | $8,821 68 | Surplus......... | $16,139 43 |

The moneys refunded on withdrawals, which amounted to $21,159 99, were never really available to the office, as also $225 00 moneys paid in by mistake, nor is the payment of them any part of its proper expenditures. During 1852, there was paid—as salaries to officials, $36,674 23; for temporary clerks, $18,992 93; for books for the library, $597 63; for contingent expenses, $13,037 98; and for agricultural statistics and purchase of seeds, $4,831 33.

*Office Labours.* — The extent of the business transacted in examining applications, granting patents, and the like, may be gathered to some extent from the following:—

*Statement of Applications Received and under Consideration during the Year* 1852.

| | | |
|---|---|---|
| Cases on the Examiners' desks, Jan. 1, 1852...... | 155 | |
| Applications received during the year ............ | 2639 | |
| | | 2794 |
| Patents issued during the year ..................... | 1020 | |
| Applications on hand, not acted upon ............ | 481 | |
| Rejections and suspensions .......................... | 1293 | |
| | | 2794 |

Included among these were—patents re-issued, 18; additional improvements, 4; extensions, 3; designs, 107. There have also been filed 996 caveats, and 2 disclaimers. 525 patents expired during the year.

These statements fall far short of exhibiting the amount of labour performed in this department. Each application for a patent is submitted to at least two thorough examinations as to its novelty and utility; most of them receive more, and not a few as many as six. Caveats, which have increased from 760 in 1851, to 996 in 1852, are also examined, no patent being issued until the caveats are thoroughly searched, lest it should conflict with some of them.

The Report urges upon the legislature the necessity of rendering the office of examiner more desirable and permanent; the most eminent skill and science being requisite for this position, and the consequences of frequent changes from dismissals and resignations being most disastrous. The natural result of the great increase in the number of applications and models deposited has been the present insufficiency of accommodation already afforded by the Patent Office building. The eastern wing therefore of the noble structure now erecting is to be appropriated to this department. Some progress has also been made upon the basement of the western wing. The basement of the principal building has been greatly improved by dressing the rough stone of which it was built, so as to make it conform in its general appearance to similar portions of the newly-erected building. In the year 1836, the date of the organisation of the Patent Office, one "examining clerk" was enabled to make all the preliminary investigations required to ascertain whether the applicant was entitled to a patent; but such has been the increase of the business, that six principal examiners and as many assistants are not now able to keep pace with it. The number of models in the office on the 1st January 1836 was 1069; in the beginning of 1851 they had increased to 17,257, and at the close of last year they numbered nearly 23,000. At this rate of increase they would amount at the end of the present century to 150,000, and the whole of the present Patent Office edifice would prove insufficient for their convenient display. To meet this contingency, it is proposed by the Secretary of the Interior to have prepared for publication by the Commissioner of Patents a careful analytical and descriptive index of all patented discoveries and inventions, accompanied by accurate descriptions and drawings, fully explanatory of the principles and practical operation of the subject of the patent. This publication would not only perpetuate the invention or discovery, by avoiding the casualties by fire and other causes, but would be a much safer and more accessible depository for them than the cabinet of the Patent Office, and in a large number of cases obviate the necessity for preserving and displaying the models. This index, if prepared by persons fully competent to the task, would almost entirely prevent the enormous useless expenditure of the time, money, and labour of applicants seeking protection for ideas already anticipated. The expense of such index could readily be paid out of the Patent Fund, which on the 1st January 1853 amounted to $40,292 38. The Commissioner of Patents remonstrates against any portion of the Patent Building being devoted to any other service, alleging as reasons against the occupation of some of the rooms by the Secretary of the Interior, the crowded and confused state of all the Patent Offices, and the delay which arises from their being restricted to such narrow limits. The relation of the Patent Office to the Department of the Interior being one of entire dependence, is attended by serious evils: the results of the scientific and laborious investigations of the corps of twelve examiners and assistants, are subjected to the consideration of the Commissioner of Patents, who, by reason of his numerous other responsibilities, and the multiplicity of patent cases, must necessarily rely, in the great majority of cases, on the fidelity and judgment of the examiners. He therefore cannot feel safe unless he can repose implicit confidence in them, and possesses the exclusive privilege of selecting them. Yet the approval now required from the Secretary of the Interior may be so exercised as to deprive him of an independent choice in this matter. Another mischievous result of the intimate relation of the two offices is, to subject them to the same political fluctuations, whilst every consideration of sound policy requires that the post of Commissioner of Patents should be a permanent one.

The Report of the Commissioner contains several valuable suggestions relative to the re-organisation of the Patent Office and the Amendment of the Patent Laws of America, which if carried into execution would considerably diminish the labour of the patent officials, simplify the routine of application, lessen the cost of protection, and effectually diminish the practice of patent infringements.

The present organisation of the Patent Office is to a great extent the mere result of expedients resorted to from time to time, as the pressure of business required, the result of which is a very ill-digested system of arrangement. Many of the officials, to whom are confided important trusts, pecuniary as well as others, are recognised only through an incidental mention of them in some statute; their duties being nowhere defined. There are also, others, who are charged with responsible services, and designated by courtesy accordingly, but who are known in law only as temporary clerks, whose compensation is discretionary, and liable to the injustice of caprice. No written code even regulates their employments, and their distribution in the offices betrays great want of method.

The department of the machinist especially requires remodelling and enlarging, and an authorised addition by law to the force under his charge, sufficient for the efficient removal, re-arrangement, and repair of the much-damaged models already deposited, the disposition of new ones, and their exhibition to visitors and inquirers.

The need of a new registry law is distinctly commented upon. It is proposed to embrace under one statute, the two analogous classes of articles, as those protected under the law of copyright and those patented as designs. Upon registering an engraving upon paper, or in any publication, with the Clerk of a District Court, at a fee of fifty cents, and depositing a copy with the Secretary of State, it is secured against infringement for twenty-eight years. If the same design is printed on silk, or upon paper-hangings, or a fire-screen, a formal application for a patent must be made, costing $15, besides the expenses attendant on procuring papers, drawings, and models; and, after all, the exclusive privilege in them exists but seven years. These incongruities indicate great want of systematic and impartial legislation, and are to some extent equally observable in the English laws of registrations and copyrights.

The American law now requires that a patent be extended, if at all, before its expiration, previous to which time, whatever controversy arises in such a case must be considered and determined. In deciding the question of extension, the Commissioner must ascertain whether the applicant has already been sufficiently remunerated, and also examine a sworn statement of his receipts and disbursements, which must be made not long before the patent expires, as it might be materially varied by intervening transactions. The usual period for presenting this statement, is not more than three or four months previous to the termination of the patent right, thus inconveniently restricting the time allowed to the Commissioner for his decision. It is proposed to obviate this, by requiring the preliminary proceedings to be closed before the time now fixed for the decision, and allowing the Commissioner such further time as he needs for forming his opinion.

Various emendations of the American Patent Law, intended to afford better security to inventors in their rights, have been brought forward from various sources, by associations interested in the subject, or individuals; others, again, have been proposed by the Patent Office itself. One of these emendations provides that when a patent has been denied by the Commissioner, the applicant, if he still insists upon it, may have one upon his own responsibility. A Patent thus issued would not, like those approved of the Commissioner, be entitled to any presumptions in its favour, nor be regarded as *primâ facie* evidence of the patentee's exclusive title; effectual precautions being taken to prevent the letters patent obtained under this Act being made use of as an official recognition of the claim, and the machinery and manufactures so patented would bear a distinguishing stamp, to preserve any person from being imposed upon by the articles, as though they were protected from infringement as under the existing law. The applicant would be entitled to a mere right to register his invention in some distinct office, or a copyright. To carry out this principle, the right of appealing from the decision of the Patent Office should be taken away. The party aggrieved might have his remedy by taking out a patent or registering his invention as thus provided, upon his own responsibility, and look to the Courts for sustaining it. This arrangement, in fact, would place the American inventor upon the same footing as the patentee in this country, where the mere grant from the Crown is not in itself any guarantee to the inventor of his right to a monopoly.

A second proposition has reference to the appointment of a permanent Board to sit upon Patent Cases, in place of occasionally resorting to arbitrators. It is also proposed to restrict the right of defence in a suit for infringing a patent on the ground that it was not novel, to those who knew before the patent was granted of the invention having been in use; whilst those who acquire such knowledge afterwards, are required to institute distinct proceedings to vacate the patent. This would prove an unjust distinction: the individual who infringes a patent, but who is not cognisant of its invalidity, is, under the present system, presumed to be aware of the existence of the patent, and therefore should be presumed to know its invalidity, and permitted to show it in his defence. The facility of manufacturing proof of like discoveries previous to that of the inventor, and dating them so far back as to render it difficult if not impossible to detect the fraud, would virtually defeat any such restriction as the above. It is further proposed to declare forfeit the machinery employed and the articles manufactured in violation of a patent, and to require of the defendant securities for the payment, in all cases where extra damages and costs might be recovered, before he is permitted to make a defence. A third proposition from the same quarter provided that after one trial establishing the validity of a patent, the patentee might recover treble damages and treble costs, if it is ever contested again; quadruple on a third trial; quintuple on every subsequent trial, with "liberal counsel's fees" in every instance; and it would not be necessary that the defendant should have been a party to the previous suits in order to make him liable to the severe operation of this statute. These several measures would very inefficiently remedy the evils of the present Patent Law, and would prove rather an oppression upon inventors than a protection. The wary and designing speculator would cautiously remove all machinery, &c. forfeited under these statutes, whilst the sequestration would fall with severity upon those comparatively thoughtless and innocent, and who have never taken such precautions. Although it is true that in many cases, irresponsible persons have been put forward to do the ostensible work of infringing, and that for them a judgment has no terror, yet it is equally possible that innocent persons may be sued, and under the proposed statute the plaintiff might entirely debar him from showing his innocence, or even demanding the proof of his guilt. Again, a party infringing a patent may have done so unconscious of any previous trial of the patent infringed, and believing himself to have a *bonâ fide* defence on the ground of having anticipated the plaintiff in his discovery. This would avail him nothing, and should he be unable to provide securities for the payment of the triple or quintuple damages and costs, he would be precluded from pleading, and judgment recorded against him without the privilege of defending himself. Again, these measures would offer temptation to speculators to obtain judgments upon patents by collusion, for the sake of exacting these multiplied damages and costs. Although the statute as proposed provides that the previous judgment must be in good faith, yet the impeachment of a fraudulent judgment is at all times a costly and hazardous undertaking, and when attempted at the risk of such aggravated recoveries, the odds are too great to be risked by any man of prudence who can avoid it. Notwithstanding that the plaintiff, under these statutes, would be liable to treble costs upon a third verdict against his patent, quadruple upon a fourth, and quintuple on all subsequent ones, (not treble upon a second trial, and so on as when he succeeds), and the further provision, that where judgments have been recovered both ways, they shall be adjusted and balanced against each other,—yet it is obvious that the facility with which the plaintiff can obtain amicable verdicts, and the difficulty of exposing them, would make these propositions worse than useless.

Few men could be found who would not make large sacrifices to speculating patentees rather than expose themselves to five-fold damages and costs, with liberal counsel fees, besides being compelled to find security to the amount before being allowed to so much as contest their guilt. Severe and aggravated as are the wrongs and depredations endured by inventors, they do not warrant measures for protection so liable to be abused, and operating with indiscriminate hardship upon the innocent as well as the guilty. The success of those persons who infringe upon patent rights with so much recklessness and impunity, are mainly attributable to the fact, that every valuable invention becomes an object of importance to a large circle, sometimes embracing the entire community, who are therefore strongly tempted to resist a patent for it, and are at once tacitly leagued against it; and also the facility of ante-dating fraudulent evasions of existing patents. Until these are counteracted, there is little hope from legislation, however stringent. The Commissioner suggests that this object may be effected by providing for a final and conclusive determination upon the validity of the patent, at a date so early that people would not have generally become aware of its value, or interested in opposing it and concocting schemes against it; and also while any alleged previous use may be readily inquired into, and its true claims thoroughly scrutinised,—public notice being extensively given of the nature and object of every invention, and all competitors required to show cause against its validity by a specified day. Should any party file an objection or opposition, an investigation to be made into the claims of the invention, and the adverse parties heard: and if the patent survives this ordeal, its validity can never afterwards be contested. It is difficult to understand at what early date this decision upon any invention could be arrived at, other than the period of its first discovery, at which time the statute proposed provides for its promulgation amongst the public, whose ignorance it appears to wish to take advantage of. It is not always on the issue of a patent that its validity is required to be questioned, and it might easily happen that an application for an invention not new, might be allowed, by reason of its value not being then perceived, or of nobody being sufficiently interested in it to oppose its grant.

The Commissioner further proposes to make the wilful infringement of a patent a crime, and punishable as such. But in criminal prosecutions, there is a strong presumption in favour of the respondent's innocence, and the danger is slight of his being convicted unless truly guilty. He is secure where the defendant in a patent suit would be exposed to serious peril; neither would it be safe to use a threat of such proceedings as a weapon of extortion: on the other hand, it would deter many a man from the offence. Hundreds, who have made up their minds to risk a pecuniary loss, would hesitate to subject themselves to the imputation of a crime; and were the stigma of infringing the laws attached to the secret trespasser of his neighbour's patent, the offence might possibly become as rare as others which are committed—not from want, but the mere love of money. Some such arrangement as this carried out in this country would immensely benefit the position of a patentee; but at the same time, it would be necessary to submit the applications for protection to some kind of examination as to their novelty and utility.

The Report enlarges upon the intrinsic importance of the Arts, their bearing upon the prosperity of a country, and the claims of inventive interests upon the attention of Congress to secure a judicious, thorough, and impartial system of patent legislature It also includes both a classified and alphabetical index of patents expired and patents issued during 1852, and the reports of the several examiners, describing some of the most important of the inventions that have passed their respective desks, which reports will become unnecessary should the bill now before the Senate, authorising the publication of an intelligible account of patented inventions, pass. Under the supervision of Examiner Henry B. Renwick, there were granted in 1852, under the diversified class of metallurgy, 115 patents; under the class steam and gas engines, 27; together with many for navigation, civil engineering, &c., making a total of 165 patents granted; 328 were rejected. Examiner L. D. Gale passed 167 patents, and rejected 256; 48 of the patents granted related to chemical improvements. J. H. Lane examined 419 patents, 137 of which applied to household furniture; 81 to mathematical and philosophical instruments; and 68 to leather, &c. The number of examinations by Henry Baldwin was 796, of which 223 were patented and 249 rejected. Examiner F. Southgate Smith patented 134 applications, and rejected, either formally or finally, 293. 141 patents were ordered to issue, and 268 rejections made by Examiner G. C. Schaeffer. The proposal to substitute a succinct and clear digest of every patent in place of the present reports of the examiners, similar to that published by the French Patent Office, would prove a very beneficial guide to the trodden paths of invention in America.—We shall give a further notice next month on the Examiners' Reports.

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*Manual of Astronomy: A Popular Treatise on Descriptive, Physical, and Practical Astronomy; with a Familiar Explanation of Astronomical Instruments, and the Best Methods of Using Them.* By JOHN DREW, F.R.A.S., Ph. D. Second Edition.

Our readers will call to mind that Dr. Drew has more than once sent scientific contributions to our pages. We are happy to be able to recommend his treatise on astronomy as a truly scientific work. Though evidently acquainted with the higher branches, he is quite successful in explaining the elementary principles in the clearest manner. The modern discoveries in this science have been numerous and striking: the increase in the number of the asteroids, now amounting to twenty-seven,—the peculiar circumstances attendant on the calculation of the place of the unknown planet, Neptune—and the last particulars respecting Saturn's rings, are all discussed in this volume. In practical astronomy, however, the author shows an originality of treatment, and sound knowledge of his subject, which we have never noticed in any previous work of the kind. Those who wish to view the stars, to use the transit and equatorial, or to found an observatory, will here find clear and practical directions. That class of educated persons who are anxious to keep up with the spirit of the age by obtaining a comprehensive knowledge of the present state of astronomy, without deducting too much time from professional engagements, will here find all they want. For the faithfulness of the representations of the telescopic appearance of the moon, Saturn, the nebulæ, and the double stars, we can confidently vouch; besides these cuts, there are drawings of various instruments, and of the author's observatory. For sea-going persons and intelligent youth the 'Manual' will be invaluable; and we are happy to see that a truly scientific work, by a man of sound knowledge, has been published, at a price which will bring it within the reach of thousands of readers.

Many parts have struck us as being particularly lucid—the tides, the calculation and construction of a lunar eclipse, the account of comets, and of Foucault's pendulum experiment may be specified. In short, the work may be looked upon as a perfect epitome of the science, and as such we strongly recommend it to our readers. The style and printing render it a suitable and elegant present for the young, who cannot fail to derive from its pages both instruction and amusement.

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*Outward Bound: being Practical Advice to Emigrants to the Australian Colonies.* By HENRY J. WEBBER, Assayist. London: Darton and Co. 1854.

It is contrary to our custom to notice works of this description, but emigration is such an important and all-absorbing topic, and this unpretending pamphlet so practical and of such great utility to all classes who contemplate adopting this step, that we willingly forsake our usual path to afford it what publicity we can.

Many pamphlets and works have been written on Australia, but not one affords that information and advice which the emigrant stands in most need of, and which 'Outward Bound' so successfully supplies. It is consequently a great boon to the emigrant; it affords him every possible information he can require, from the time he has made up his mind to leave his native land till he settles down in the colony: it is, in fact, the emigrant's *vade mecum*. As the author has but very lately returned from the colony, and has learnt, what he endeavours to teach others, in that dear school, "Experience," he is fully qualified to serve as their guide. He not only gives every requisite information and advice with respect to the voyage, but enters into the various incidents connected therewith; draws a faithful picture of the country, its inhabitants and customs; states who ought to emigrate and who ought not; affords much valuable advice to intending diggers and storekeepers; and shows the various methods of distinguishing gold from other metals. And moreover, the price being so low, it is within the reach of all. We extract that which we think will interest our readers; and, in conclusion, express our candid opinion that no emigrant should leave England without it. With respect to Sydney—

"The streets are spacious, well laid out (with the exception of the pavement which is an absolute disgrace to the city), and lighted with gas; while the houses and shops are as substantial and elegant as the generality in London. Most of the houses and buildings are built of sandstone, which gives them an air of substantiality and elegance. There is a peculiarity about Sydney and Melbourne (the latter more especially) with regard to the buildings: for instance, there will be a handsome stone edifice—perhaps one of the banks—which would be an ornament to London, and next to it a little wooden house or dilapidated shed; then a row of fine shops or houses, and perchance a garden or two struggling for existence; and then more wooden houses or sheds. But this appearance is rapidly declining before the giant strides of commerce. Very few of the houses are built in consonance with the climate. The majority of the superior ones are fitted up with cedar, which gives them a handsome appearance. Most articles of furniture are made of this wood; which is an excellent and cheap substitute for mahogany. The warehouses are numerous and commodious. With the exception of the banks, Government house, and an elegant protestant cathedral, in the course of erection (the first stone of which was laid, I believe, fourteen years ago,—so much for the energy of the people!), there are very few buildings worthy of note."

## FORMULA FOR SETTING OUT EGG-SHAPED SEWERS.

Sir—Two things appear to me as proven by the discussion of questions relative to the drainage and sewerage of towns—viz., that all the main sewers should be brick, and that their cross section should be "egg-shaped," the arch and invert being connected by a circle tangent to both. It may be useful to some of your readers, to know how the radius of this circle can be found.

If the circle which forms the invert touches the circle forming the arch, then if $a =$ rad. of the arch, and $b =$ rad. of the invert, $\dfrac{a^2 + ab}{a - b} =$ rad. of the circle tangential to both.

If the circles forming the arch and invert either do not touch or intersect, then putting $c =$ the distance of the centres apart, $\dfrac{a^2 + c^2 - b^2}{2a - 2b} =$ rad. of the tangential circle.

*Claremont-place, Belfast,*
*February* 11, 1854.

William T. Matier, C.E.

## INSTITUTION OF CIVIL ENGINEERS.

*Jan.* 31.—James Simpson, C.E., President, in the Chair.

On reading the Minutes of Discussion of the meeting of January 24th, attention was directed to the statement of the experiments recently made at Alnwick, on the quantity of water discharged through a "pot-pipe," of 18 inches diameter (*ante* p. 77); for while, on the one hand, the results of the experiment sufficiently confirmed the accuracy of the formulæ of Du Buat, Eytelwein, Smeaton, Prony, Hawksley, and other investigators, and as decidedly contradicted the results published in the "Blue Books" emanating from the Board of Health, these results, nevertheless, differed too considerably from other consistent conclusions to be fully relied upon, and it was therefore desirable that this experiment should not be taken as a datum upon which to found any hydraulic law for the determination of the quantity of water which might be transmitted through tubes. For this purpose, indeed, the cited experiment must be deemed unsatisfactory; because pot-pipes were never of uniform or exact diameter,—inclinations were always more or less vaguely stated, joints were seldom sound, and when the discharge was into free space, the differential level was rarely satisfactorily afforded. Moreover this experiment itself was in some respects contradicted by very carefully conducted experiments, made by Monsieur Couplet, at Versailles, on a pipe 18 inches in diameter, the results of which were extremely consistent with the mathematical determinations successfully resorted to by all practical hydraulic engineers. The experiment by Monsieur Couplet was made on a pipe of 43,200 inches long and 18 inches diameter, the motive head was 145 inches (all French measures), the calculated velocity was 40½ inches, while the observed velocity was 39½ inches, differing from the velocity calculated from established formulæ only about 3 per cent. It was also contended to be extremely undesirable that centralised authorities should continue to exist, as it was uniformly found that these authorities did great mischief by the wide dissemination of errors, apparently under Government influence, and by the consequent repression of scientific and practical improvements.

The Paper read was "*On Macadamised Roads, for the Streets of Towns*," by J. Pigott Smith, Assoc. Inst. C.E.

The lengthened experience of the author, as surveyor to the corporation of Birmingham, having under his charge about 150 miles of street road and 50 miles of turnpike road, enabled him to express confident opinions on the comparative cost, durability, and general qualities of paving and of broken stone, for roads and even for streets, subject to a considerable amount of heavy traffic. The parties chiefly interested in having good roads were shown to be the owners of carriages and horses, and the ratepayers, at whose expense the roads were originally constructed and subsequently maintained. For both these classes, "cheap roads" (*i.e.*, those of small first-cost) were contended, generally, to be the dearest; horse-power being uselessly expended, carriages destroyed, and constant repairs to the surface of the road being necessitated. Any undue increase of tractive power was shown to fall indirectly on all who purchased any commodities conveyed through the streets, and the annoyances and hindrances to commerce arising from ill-paved or ill-kept, muddy, dirty, and noisy streets, were patent to all. The necessity was thence deduced for having the roads and streets so constructed, that the surface should be firm, even, and smooth without being slippery, and be free from mud, dust, or loose stones. To attain this, the foundation should be of firm material, well consolidated, and perfectly drained; then covered with stones broken to uniform dimensions, well raked in and fixed by a binding composition of grit, collected during wet weather by Whitworth's sweeping machine and preserved for the purpose. This binding being regularly laid on, and watered, if in dry weather, would, in great thoroughfares, consolidate the new metal in a few hours, preserving the sharp angles of the stones, which assumed all the regularity of a well-laid pavement, with a considerable saving of material and a firmer crust than by the ordinary method of allowing the vehicle to pass for many days over the uncovered surface of the new stones, grinding off the angles, with a deafening noise, and forming dust or mud, to be carried on to the footpaths and into the houses and shops.

Instances were given of the advantages of this system, of using the grit for binding, which should however be that collected by the sweeping machines, and not mere slimy mud. A street in Birmingham, subject to great traffic, had been thus perfectly made and consolidated in five days, whereas, under the ordinary system, three months would have been required to produce the same effect. The repairs were capable of being effected at any period of the year; under no circumstances were the street surfaces permitted to be worn down, and they were never stopped, as was the case for lifting and repaving.

Rules were then given for keeping the surface in perfect travelling order, for picking off all loose materials, for sweeping and never scraping, for preserving the profile of the surface and getting rid of all lodged water, for light watering in dusty weather, and heavy watering when there was adhesive mud that could not be otherwise removed by the long brushes of Whitworth's sweeping-machines, which were contended to be indispensable for keeping roads and streets in good repair, and for preventing the nuisances of mud and dust.

The system employed in London, of heavy watering without removing the mud; or of scraping and of hand-sweeping and lifting by shovels into carts, was shown to be bad and expensive. The loss of speed, and the extra power required to be exerted by horses drawing carriages over street surfaces in the state of those in London, were shown to be as much as 25 per cent. as compared with the work done in Birmingham. The employment of a better system, combined with the use of the sweeping-machines, had been productive at Birmingham of an economy of nearly one-third of the materials employed for the construction and repairs of the streets and roads.

Instances were given of the actual results of the system of washing and sweeping parts of the Quadrant, Regent-street, where the method had been satisfactorily proved to have produced superior effects; but prejudice had induced obstinate adherence to the old system, to the annoyance of the public and with the derision of all foreigners who visited the metropolis. The actual state of all the leading thoroughfares could vouch for the justice of the criticism on the present metropolitan system.

The greatest amount of wear and tear of macadamised street surface, in Birmingham, was shown to be four inches per annum; the average might be therefore taken at two inches;—the cost of maintenance was fourpence per superficial yard, and that of watering and cleansing was twopence, giving a total of sixpence per yard per annum. Paving cost fifteen shillings per yard, it required to be renewed once in fifteen years, and the cleansing cost about halfpenny per yard. Paving was, therefore, evidently about double as expensive as macadamising, at Birmingham. It was therefore contended, that macadamised roads and street surfaces, if properly constructed and carefully managed, well water-cleansed for mud and watered for dust, brushed or swept by machinery, maintained with an uniform surface, and not permitted to become degraded, were well adapted for towns and cities of average traffic, and for many localities in and around the metropolis.

*Feb.* 7.—In the discussion upon the above Paper, numerous details were given of the comparative prices of the materials in the country and in the metropolis,—the method of laying them down,—the successive employment of set paving stones in large thoroughfares, then in less frequented streets, and ultimately breaking them up for macadamising; thus giving the materials an almost unlimited duration. The use of the grit, as collected by the sweeping machines, was admitted to be advantageous for binding the metalling quickly, and preventing the abrasion of the angles of the stones. It was however shown, that the traffic of country towns was so vastly inferior, in amount and weight, to that of the metropolis, especially since the introduction of the heavy railway and other vans, travelling at considerable speed upon comparatively narrow wheels, that a system of forming streets or roads which would endure well in one case was not applicable for another, and hence the present bad condition of Parliament-street and other streets which had been macadamised, and which it was contended could only be maintained, even in their present state, at a cost greatly exceeding that of the paved streets of the city.

The Paper read was a "*Description of the Navigation and Drainage Works recently executed on the Tidal portion of the River Lea.*" By N. Beardmore, M. Inst. C.E.

The first part contained a general description of the ancient navigation of the River Lea, and of the gradual improvements introduced into the class of barges frequenting it, and the burthens carried by them. Allusion was made to the difficulties and continual delays which had prevailed, up to a very recent period, in the tidal portion, forming the junction with Bow Creek and the Thames at Limehouse; difficulties which were aggravated by the navigation being the common supply for five tidal mills. The new works consisted of stop-gates across the main channel of the Lea, near Old Ford Lock, established for preventing the water from being drawn down by the tidal mills to the eastward; also a lock for a similar purpose and to pass barges on St. Thomas's Creek, near Bow Bridge; and a new overfall, to pass surplus water to the Three Mills.

Three large floodgates, each 18 feet in width, were constructed near Four Millls, with a new tidal lock, adjacent to the spot, in order to pass vessels into Bow Creek; the ancient system being to pass craft by a single pair of gates, only available by drawing down the head water, and frequently during neap tides, the water did not rise high enough to enable the gates to be opened at all.

The remaining new works consisted of a lock at the east end of the Limehouse cut, to retain the water when, in consequence of floods, the Bromley floodgates were required to be opened; the lock being of such a width as to allow vessels of 21 feet beam to enter the cut; the former lock being only capable of admitting barges of 13 ft. 6 in. beam.

In consequence of the treacherous nature of the material at the Bromley end of the Limehouse cut, it was necessary to re-excavate the cut,—to give flatter slopes, and also to build retaining walls of Kentish rag, for the towing path.

The paper concluded by alluding to other considerable works which had been recently executed at the lower end of the navigation, where it formed a junction with the Regent's Canal basin, thus giving access to Armstrong's hydraulic coal lifts and cranes, with the dock conveniences and the wider locks, recently executed by Mr. W. Radford for the Regent's Canal Company.

*Feb.* 14.—The Paper read was "*On the Principles and Construction of Locks.*" By A. C. Hobbs, Assoc. Inst. C.E.

The author's object was to give a brief review of the mechanical principles involved in the construction of locks, and the degree of security hitherto achieved by manufacturers. The paper commenced by asserting as an axiom, that the highest point of security to be attained in the construction of locks must consist in the fact, that the possibility of picking or opening them, without their true keys, should depend entirely on chance; and that notwithstanding the immense variety of locks already invented, there were really but three absolutely distinct principles involved in their construction,—so classed without reference to dates and for convenience of description.

The first principle included all locks having a series of fixed obstructions, or wards, in and about the key-hole, to prevent any instrument except the key being turned in the lock; this principle was shown to be inefficient, however complicated the construction might be, as the wards themselves afforded the means of ascertaining the form of key required to open the lock.

The second principle was that of the letter, or puzzle lock, which appeared to carry out the principle or doctrine of chance, to the fullest possible extent. But in this case, also, a method was shown by which the lock could be opened as easily as in the former; proving, that the inventor of that class of lock had failed to accomplish the object of producing a fastening whose security was dependent only on mere chance.

The third principle, or last class of locks, included all those possessing a series of moveable pieces called slides, pins, tumblers, &c., placed within the case of the lock, and which pieces must be operated upon and moved into certain given positions, by a key, before the bolt could be shot. This principle was illustrated by descriptions of the Egyptian lock, the Bramah lock, the inventions of Barron and of Bird, the Detector of Mitchell and Lawton, and the later improvements of Chubb and of Cotterill (of Birmingham) and others. Allusion was then made to the great reliance which until recently had been placed on these locks, and an explanatinn was given of the principle on which all locks of this description could be as easily picked as their predecessors.

The author then commented on the necessity of devising some simple and effective means by which the defect, common to all the above locks, might be remedied without adding materially to the cost. This desideratum he had endeavoured to secure by the introduction of what was called a moveable stump, which projection, instead of being riveted into the bolt, was fixed to a piece, moving upon a centre or pin at the back of the bolt. The action of that piece was such as to render it impossible to ascertain the true position of the tumblers, for on any pressure being applied to the lock for that purpose, the stump by its motion locked the bolt and left the tumblers at perfect liberty. The author stated his conviction, that this apparently slight alteration rendered it impossible to open such a lock, except by the mere chance or accident of a key fitting it; there being no possible means of ascertaining the form of key requisite to open it surreptitiously. Since the introduction of this lock, several attempts had been made to produce the same result without actually copying the original, but with very little success.

An additional principle of security, devised in America, was then pointed out, in the celebrated permutating bank lock, invented by Robert Newell, of the firm of Day and Newell (New York), of which invention Mr. Hobbs was the proprietor in this country. Previous to the introduction of that system, permutating keys had been used, but they required that the lock itself should be altered, to suit any new adjustment of the bits of the key, whereas, in the American lock, the key alone being altered, produced by its own action the corresponding arrangement in the lock; by this ingenious contrivance, the person using the lock became his own lock-maker, and was able to render the key useless to any other person, by a simple change in the bits after locking the door. Such locks, whose numbers of permutations varied from 720 to 479,001,600, according to the number of bits in the key, were intended principally for strong rooms of banks, and other establishments where large amounts of property were deposited; they were therefore comparatively expensive, and were necessarily of larger size than locks required for ordinary use.

In conclusion, it was remarked that questions would continually arise, as to the violability or inviolability of particular locks and especially of new inventions. The author, however, claimed to have established that any new modification or arrangement of the parts of locks, which did not affect the principle of construction, could have no particular claim to security, or conversely, that if it could be shown that any lock was constructed on a principle not hitherto violated, it might be deemed secure, but certainly not unless such a claim could be made good. In respect to the locks alluded to in the paper, the author justified his statements by the two facts,—that he had not only elucidated the principles on which all such locks might be picked, but that he had actually performed all that had been described. Finally, a hope was expressed, that whatever had been done and said to enlighten the public as to the insecurity of many locks now in use instead of causing any unpleasant personal feelings, would stimulate lock manufacturers to produce what was really required—viz., secure locks, adapted to all purposes, of good workmanship, and at a moderate price.

*Feb.* 21.—The evening was devoted to the Discussion on Mr. A. C. Hobbs' Paper. A succinct description was given of the various recent modifications generally introduced by makers of locks, and it was argued that most of them were simply alterations of form, without materially adding to the security. An exception might perhaps be made in favour of Mr. Denison's lock, which was so constructed that the bolt was shot by turning a handle, without the intervention of a key, which, in fact, was only used for placing the tumblers in a proper position to allow the bolt to be withdrawn or unlocked by the handle,—the keyhole being kept closed during the passage of the bolt; the key might therefore be always retained in the possession of one person, whilst the lock could be closed by any subordinate,—this was important in banks and other similar establishments.

The principle of the bolts being shot by a handle was not new, but the other arrangements were admitted to possess novelty.

Mr. Whishaw's electro-magnetic lock now exhibiting at the Polytechnic Institution was explained, but was admitted not be applicable to all the ordinary uses for locks.

The principle of Mr. Cotterill's "Patent Climax Detector Lock" was then examined, and it was shown to be entirely based upon the Bramah lock, but was less secure in its arrangement, inasmuch as the form of the key admitted of so little variation in the depth of the grooves for moving the slides, that a lock having six slides might be opened by the end pressure of a piece of soft wood, and that any lock on that principle, with any number of slides, could be easily picked by the pressure system.

It was explained, that the American permutating lock, which had been so fully described in the paper, was not intended for ordinary domestic purposes, but for banks and establishments requiring extreme precautions for security, and that the chief object in the introduction of Hobbs' moveable stump or protector lock was to supply a secure lock at a moderate price.

In the course of manufacturing, as might be naturally supposed, the weak points of this lock had not escaped detection, and it was soon discovered, that although the principle was correct as long as the stump remained moveable, if by any means the stump could be held fast, the lock became one of the ordinary tumbler locks, and was as easily picked as the others. For instance, in a till or drawer lock, where the keyhole was parallel to the bolt, it was easy, by the insertion of a piece of watch-spring beneath the lock, to catch and hold the stump, and to open the lock. This however was readily prevented by the insertion of a tongue in the back plate, fitting into a corresponding groove in the back of the bolt, thus cutting off all access to the moveable piece under the bolt; and further, to preclude access to the stump itself, a piece of steel was riveted into the front plate, reaching through the tumblers into a groove in the bolt, thus placing an effectual barrier between the keyhole and the stump. With these slight additions, which were now introduced, it was contended, that locks constructed on the principle of the moveable stump might be considered secure.

It was shown, that Mr. Goater, who was connected with the establishment of Mr. Chubb, had succeeded very ingeniously in picking three of Hobbs' till locks by the means which had been described, those locks however not having the additions for security which had been alluded to. This opening of these locks was admitted to be perfectly legitimate, showing slight defects in the details of construction, but demonstrating the correctness of the principle; and it was argued, that it was only by such means the manufacture of locks could be tested and improved,—indeed, that the lock-makers were greatly indebted to Mr. Hobbs for showing them the weak points of the locks constructed prior to 1851.

The manufacture of locks in this mechanical country had hitherto been conducted in the rudest manner, and with the most primitive tools, and whilst the price of common and insecure locks was incredibly low, that of locks of good construction was much too high to introduce them into general use. It was therefore the object of Mr. Hobbs, by the employment of good machinery, to produce locks of uniformly correct construction on sound principles, and at such a modified scale of prices, as would insure their general adoption; being assured, that whoever might be the maker, the most secure locks at the lowest price would eventually take the lead with the public.

## NOTES OF THE MONTH.

*Proposed Central College of Design, North Staffordshire.*—The design for this building is by Mr. Robinson, of Wolverhampton, and was selected from a number submitted in competition. The style is the Revived Italian. It has an ornamental centre, flanked by two plainer wings. The centre has a rusticated basement, supporting a façade of the Corinthian order, with detached columns and arched windows: the whole is surmounted by a group of figures emblematical of the union of the fine arts. The ground-floor contains an entrance-hall, serving as a statue gallery, and having on one side a large room for a museum of pottery, and on the other a similar one for the purpose of a library. At the extreme end of this hall is the lecture theatre, capable of accommodating from 250 to 300 students, with lecturers' room, &c. adjoining. The remainder of the ground-floor is occupied by the laboratory—a room for the study of technical classes, more especially for those of casting in metal and firing of pottery—and a dwellinghouse and office for attendant. The upper floor is principally occupied by the large studio, which is divided by means of moveable partitions into three compartments, for the painting, drawing, and life classes of the students. When these partitions are removed it will form an additional room for the exhibition of works of art, or for lectures, &c.; adjoining this room are others devoted to ladies' and gentlemen's private classes, head-master's studio, and a room for the study of anatomy.

*New and Repaired Churches.*—The Incorporated Society have made grants of money in aid of the following objects:—Building churches at Wrightington, near Chorley: Crugybyther, near Knighton; Halse Town, in the parish of St. Ives, Cornwall; Pinfold, near Rochdale; Penybontfawr, near Oswestry; the new district of St. James, Plymouth; Aberystwith; Langley Burrell, near Chippenham; and Portsea; rebuilding the parish churches of Llandygwydd, near Newcastle Emlyn; Llanddarog, near Llanelly; and Shrewton, near Devizes; enlarging &c., the churches at Tisbury, near Hindon; Much Dewchurch, near Ross; Wivenhoe, near Colchester; and St. Mary, Princes-road, Lambeth. The committee also increased grants formerly made for re-arranging the seats in the church at Llannor, near Pwllheli; and rebuilding the church at Ringwood, Hants, under the special circumstances represented.

*Congregational Chapels.*—In March last, a society was formed, entitled "the English Congregational Chapel-Building Society," for the purpose of erecting 50 chapels in various parts of England, in five years. Various architects who had had experience in chapel-building were invited to send in designs for model chapels, and out of about eighteen received, the committee have selected five as most in accordance with their views. The designs selected were by the following architects:—One set of Gothic and one set of classic designs, with several elevations adapted to the same plans, by Mr. Andrew Trimen, of London; one set of Gothic designs, by Messrs. Foster and Wood, of Bristol; one set of Italian designs, by Messrs. Bidlake and Lovatt, of Wolverhampton; and one set of Italian designs, by Mr. T. Oliver, jun., of Sunderland. The committee have also commenced the erection of a chapel in Queen's-square, Brighton, of which Messrs. Joseph James and Raffles Brown are the architects. The whole of the chapels are to be erected by voluntary contributions, and there are several donors of 1000*l.* each. The treasurers are Messrs. Joshua Wilson, Arthur Morley, and Rice Hopkins; and the secretary is the Rev. J. C. Gallaway, A.M. A similar society was formed in London, five years ago, and it has aided in providing sixteen chapels in the metropolis. It is now erecting two large chapels, the one at Craven-hill, Bayswater, of which Mr. Trimen is architect; and another at Blackheath. The Lancashire Congregational Chapel-Building Society is engaged to aid in supplying twenty chapels; and there are several liberal contributors to its funds, including Mr. Hadfield, M.P., 5000*l.*; Mr. Kershaw, M.P.; Mr. Barnes, M.P.; and other gentlemen, 1000*l.* each.

*Architecture in Germany.*—The Grand Duke of Weimar has laid the foundation for the chief tower of the Wartburg, which will occupy the same place where anciently stood the central tower which surmounted the whole extent of the old Burg, and separated the two courts.—The Austrian government has ordered the complete restoration of the great antique Temple of Jupiter, at Spalatro. The plans and drawings for this work are by M. Vincenz Andric, architect.

*The Rotherhithe Marshes.*—The Admiralty report on the proposed Wellington Docks, to be constructed at Rotherhithe, on the marsh lands adjoining the Greenwich railway, is of a favourable character. No objection is made to the bill as regards its effect on the navigation of the river, and it is pointed out that, as the site selected is low and unwholesome for houses, the conversion of such a district into docks and quay, besides the facility it would afford to maritime commerce, must prove a salutary measure to the metropolis.

*Comparative Cost of Wooden and Iron Built Ships.* — In a recently-issued circular, by Mr. James Hodgson, consulting engineer, of Liverpool, we find the following comparative annual cost of the working of a wooden and iron ship of 1000 tons each: —"Suppose a wooden ship of 1000 tons to cost 16,500*l.*, or 16*l.* 10*s.* per ton; then suppose an iron ship to cost 13,500*l.*, or 13*l.* 10*s.* per ton, both fitted for the East, we have the following result: *Wood.*—16,500*l.* at 3 per cent. for insurance, 495*l.*; ditto at 5 per cent. for depreciation, 825*l.*; ditto at 5 per cent. for interest, 825*l.*—2145*l.*; deduct 1350*l.*—795*l.* *Iron.*—13,500*l.* at 3 per cent. for insurance, 450*l.*, ditto at 2 per cent. for depreciation, 270*l.*; ditto at 5 per cent. for interest, 675*l.*—1350*l.*; difference in favour of iron, 795*l.* A wooden ship of 1000 tons trading to the East, will not carry more than 1500 tons, which, at 5*l.* per ton for the voyage out and home, will give 7500*l.* while an iron ship of 1000 tons, built from the same external lines, will carry 1800 tons, which, at 5*l.* per ton, will give 9000*l.*; deduct 7500*l.*, and the difference will be 1500*l.*, making a total in favour of an iron ship of 1000 tons of 2295*l.* In the above statement, it will be seen that I have taken the lowest estimated cost for a wooden ship, and also the lowest depreciation of the same; and as regards the iron ship, I have now under my superintendence three large ships for one gentleman, of nearly 1500 tons each (exclusive of others, one of which is 2700 tons, old measurement), which will cost less than 13*l.* per ton, so that the above case is under rather than over rated in favour of iron ships."

*Ericsson's Caloric Engine.*—After so much has been said, and indeed continues to be said, on this and the other side of the Atlantic respecting Captain Ericsson's engine, a few words may not be out of place on a cause which will ever prevent its being commercially useful. Water at the boiling temperature evaporates into steam of about 1700 times the volume of water, and therefore, if one had to pump in water to the boiler against the steam pressure, the loss of power, excluding friction, would be about 1 in 1700. At a temperature of 324½° Fahr., the pressure in the boiler would be about 90 lb. to the square inch, and the volume of steam 325 times that of the water. Therefore, at the available pressure of $90 - 15 = 75$ lb. to the inch, the force lost by the pump to supply water to the boiler would be 1 out of 325, leaving 324 profitable power. Now, at the temperature of 324°, a volume of atmosphere measuring at 32° Fahr. 1000 cubic feet would be expanded to about 1608 feet. The power expended therefore on the feed-pump would be $\frac{1000}{1608}$ part of the power of the engine, supposing it was working against a vacuum; or the useful power generated by the heat is only $\frac{6}{10}$ths, or 60 per cent. of the power employed in working the feed-pump above it, whereas in the steam-engine it is at least 324 times as much, or 32,400 per cent. We have not gone closely into the calculations, but enough has been shown to convince any one of the hopelessness of employing air-engines in place of steam, unless a size of a monstrous character is used.—*Herapath's Journal.*

*Consumption of Smoke.*—The principle adopted by Messrs. James Hume and Co., of the Haymarket Flour Mills, Edinburgh, is that of obtaining more perfect combustion of the smoke, by exposing it to an extensive heated surface, and by the admission behind this heated surface of fresh unconsumed air, which causes its ignition. It is applied to a double-furnace Cornish boiler of an engine of 90-horse power, and the coals used are all Scotch, and consist of one-third dross and two-thirds mixed coal. At the further end of each furnace, the space between the level of the bars and the roof of the flue is divided into eight spaces by seven bricks, each 3 ft. 6 in. long, 4 inches thick at the bottom, and ¾-inch thick at the top; and reaching to the underside of the boiler, so that they vary in depth or height, with the radius of the boiler-flue, from 14 inches in the centre to 6 inches at the sides. From their position at the end of the furnace, these bricks soon attain and preserve a white and and heat, and separate the smoke, which must pass through them to the flue. The fresh air is admitted at the further end of the ash-pit, immediately under the furnace, by an air-valve 15 inches by 5 inches, which is very simply and readily worked by a rod under the bars, terminating with a handle just under the furnace-door. Should the draught admit of it, the air-valve can remain open, or it may be opened only when coaling. The apparatus has been in constant use for the last six months, and continues to give entire satisfaction.

*Sanding Apparatus for Railways.*—Mr. J. Beall, of Effingham-place, Cheshunt, Herts, has patented an apparatus for depositing sifted sand, grit, or other suitable material, on lines of railway, immediately in front of the driving wheels of a locomotive engine, in cases where the rails are slippery, or the steepness of the gradient may render it necesssary to increase the bite of the driving-wheels. The apparatus is so contrived, by means of reservoirs, valves, and tubes, that the deposit of the sand, &c. on the rail can be regulated in any quantity that may be required. When the rails do not require sanding, the closing of a valve prevents the dropping of the sifted sand. Cases often occur in a slippery state of the rails with a heavy train, when it is desirable to increase the bite of the driving wheels, and propel the train forward when behind time or in danger of being run into by a fast train.

## NEW PATENTS.

### PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAW AMENDMENT ACT.

*Dated October* 11, 1853.

**2330. C. Rowley, Birmingham—Improvements in ornamental dress-fastenings.**

*Dated October* 25.

**2468. M. Davis, Cloudesley-square, Islington — Improvements in the treatment of fibrous materials other than flax and hemp. (A communication.)**

*Dated November* 8.

2595. G. Shepherd, King William-street—Improvements in the construction of railways.

*Dated November* 14.

**2638. W. Anderson, jun., and A. W. Murphy, Glasgow—Improvements in that class of ornamental fabrics usually termed "Ayrshire sewed work."**

*Dated November* 19.

**2689. A. Castets, Paris—Improved composition for curing diseases in the feet of animals.**

*Dated November* 22.

2707. E. Briggs, Castleton Mills, near Rochdale—Improvements in weaving and manufacturing raised pile fabrics, and in machinery employed therein.

*Dated November* 28.

2778. J. Lord, Farnworth, Lancaster—Improvements in the manufacture of certain articles for ladies' under clothing, and in fabrics for the same.

*Dated December* 5.

2827. E. Lavender, Deptford—Improvements in apparatus for subjecting substances to the action of heat, for the purpose of carbonising, calcining, or combining such substances, or for subjecting such substances to the process of distillation.

*Dated December* 10.

2880. J. H. Johnson, Lincoln's-inn-fields—Improvements in moulding, more particularly applicable to toothed wheels. (A communication from M. de Louvrié, St. Marc, France.

*Dated December* 16.

2933. C. Goodyear, St. John's-wood—Improvements in the treatment and manufacture of india-rubber. (Partly a communicatoin.)

*Dated December* 20.

2964. A. Thomson, Glasgow—Improvements in setting-out and marking the rivet-holes in the plates used in constructing iron ships, boats, boilers, and other vessels.

*Dated December* 27.

2996. E. J. Hughes, Manchester—Improvements in sewing-machines. (A communication.)

*Dated December* 28.

3011. S. Barnes, Oldham, Lancaster—Improvement or improvements in the construction of looms.

*Dated December* 29.

3019. J. W. Crossley, Brighouse, York—Improvements in the production of surface finish to certain descriptions of fabrics composed of worsted, cotton, or silk, or combinations thereof.

*Dated December* 30.

3023. W. Pickstone, Radcliffe, and J. Booth, Pilkington, Lancaster—Improvements in looms for weaving.

*Dated December* 31.

3039. J. Bernard, Regent-street—Improvements in stitching and ornamenting various materials, and in machinery and apparatus connected therewith.

*Dated January* 5, 1854.

27. J. Mason and L. Kabery, Rochdale—Improvements in machinery or apparatus for preparing cotton, wool, and other fibrous materials for spinning.

*Dated January* 7.

37. W. Aspdin, Blackburn, Lancashire—Improvements in looms for weaving.
39. A. B. Baron Von Rathen, Wells-street—Improvements in chimneys and flues of houses, and in stoves to be employed therewith, whereby better draught will be obtained, consumption of fuel will be diminished, smoke, fog, and night-damp will be prevented from entering apartments, more warmth will be thrown out, and whereby fire in the chimney can be readily extinguished.
41. J. H. Johnson, Lincoln's-inn-fields—Improvements in machinery or apparatus for effecting agricultural operations, and in communicating power thereto; parts of the said improvements being applicable to the obtainment of motive power for general purposes. (A communication.)
43. J. G. Taylor, Glasgow—Improvements in writing apparatus.

*Dated January* 9.

45. B. Burleigh, Great Northern Railway, King's-cross—Improvements in railway switches and chairs.
47. R. A. Tilghman, Philadelphia—Improvements in treating fatty and oily matters, chiefly applicable to the manufacture of soap, candles, and glycerine.
49. W. Garforth and J. Garforth, Dukinfield, Chester—Improvements in mechanism or apparatus for retarding or stopping the motion of locomotive engines and other railway carriages.
51. W. Taylor, How-Wood, Renfrew—Improvements in furnaces and fireplaces, and in the prevention of smoke.

*Dated January* 10.

53. W. Brown, Bradford, York—Improvements in preparing to be spun wool and other fibrous material.
55. Rev. W. R. Bowditch, Wakefield—Improvements in economising fuel, and in the more economical production of light and heat.
57. E. Townsend, Boston, U. S.—Improvements in machinery for sewing cloth, leather, or other material. (A communication from W. Butterfield and E. M. Stevens, Boston, U. S.)
59. J. R. Engledue, Southampton, and T. Burningham, Millbrook—Improvements in furnaces.
61. W. L. Tizard, Aldgate—Machinery for stamping, crushing, washing, and amalgamating gold and other ores.

*Dated January* 11.

62. A. A. Masson, Paris—Improvements in the manufacture of thread or wire to be used for making gold or silver lace.
63. J. J. W. Watson, Old Kent-road—Improvements in signalling.
64. H. Bennettsmith, St. Sepulchre's—A machine for mowing or reaping all kinds of corn, grass, clovers, or any other field growth and lawns.
65. D. Semple, 1st Bombay European Regiment of Fusiliers, now at Aden, South Arabia—An improved guide for the finger-boards of musical stringed instruments.
66. W. Watt, Glasgow—Improvements in the application of heat to drying purposes.
67. F. L. Bauwens, Pimlico—Improvements in treating fatty matters previous to their being employed in the manufacture of candles.
68. R. A. Brooman, Fleet-street—Improvements in extracting gold from the ore. (A communication.)
69. R. Lister, Scotswood, Northumberland—Improvements in distilling apparatus.

70. M. Vetillart, Le Mans, France—Improvements in drying woven fabrics, yarns, and other goods.
71. H. M. Leeson, Greenwich—Improvements in gas-burners.
72. F. Tussaud, Paris—Universal pump-press, with continuous action, called "Continuous Producer."
73. A. Ponçon, Marseilles—Obtaining a motive power.

*Dated January 12.*

74. J. W. Wrey, Upper Berkeley-street West—A new and improved method of transmitting motion.
75. T. Waller, Ratcliff—Improvements in register-stoves, and other stoves or fire-places.
76. T. E. Moore, St. Marylebone—Improvements in apparatus to be used for extinguishing fires.
78. J. F. Boake, Dublin—Improvements in and applicable to certain lamps or lanterns, so that either candles or oil may be used therein with facility.
79. J. W. Partridge, Birmingham—Improvements in the manufacture of soap.
80. J. Bethell, Parliament-street—Improvements in manufacturing coke.
81. L. J. Anaer, Paris—Improvements in the manufacture of metallic tubing.
82. T. F. Henley, Cambridge-street, Pimlico—Improvements in the preparation of certain colouring materials.
83. A. E. L. Bellford, Castle-street, Holborn—An improvement in the manufacture of glass. (A communication.)
84. S. Wilkes, Wolverhampton—Improvements in the construction of chairs and rails for railways.
85. J. H. Johnson, Lincoln's-inn-fields—Improvements in the preparation of glycerine, and in its application. (A communication from V. Courboulay, Paris.)
86. R. Maclaren, Glasgow—Improvements in moulding or shaping metals.

*Dated January 13.*

87. W. Eassie, Gloucester—Improvements in trucks used on railways.
88. A. Parsey, Crescent-place, Burton-crescent—Improvements in machinery for obtaining and applying motive power by means of compressed air and other fluids.
89. P. O'Malley, Dublin—Manufacture of a new drink or beverage from certain vegetable and other substances, and the conversion thereof into vinegar.
90. T. B. Foulkes, Chester—Improvements in the manufacture of self-adjusting gloves.
91. J. Wilkinson, Manchester—Improvements in the manufacture of dies for producing printing surfaces for calico printers, applicable also to embossing.

*Dated January 14.*

92. J. Newman and H. Jenkins, Birmingham—Improvements in the manufacture of spoons, table-forks, and other articles.
93. J. Bird, St. Martin's lane—Improvement in taps and cocks.
94. J. Jeffreys, Carlton-villas, Maida-vale — Improvements in the manufacture of mineral charcoal and coke, and in adapting open grates for the combustion of them.
95. A. Dobson, Bolton-le-Moors—Improvements in looms for weaving.

*Dated January 16.*

96. C. F. Stansbury, Cornhill—A new and improved mode of propelling machinery. (A communication from B. Hughes, Rochester, U. S.)
97. W. Crosskill, Beverley, York—Improvements in the constructon of portable railways.
98. J. Newall, Bury—Improvements in machinery or apparatus for stopping or retarding the progress of railway and other carriages, and in the mode or method of connecting two or more carriages with the said apparatus together.
99. P. Grant, Manchester—Improved roller used in the processes of letterpress, copperplate, and lithographic printing.
100. P. Blaker, Crayford, Kent, and W. Wood, Chancery-lane—Machine for crushing coal, and the refuse arising from the combustion of coal used for brickmaking and other purposes.
101. G. F. Wilson, Belmont, Vauxhall—Improvement in the manufacture of candles and night-lights.
103. P. G. Julyan, Bath-street, Birmingham—Improvements in communicating signals to engineers, guards, and others in a moving railway train.
104. J. Spires, Lower Drummond-street, Euston-square—Improvements applicable to boots and shoes.

*Dated January 17.*

106. W. Brown, Camberwell—Improvements in printing machinery.
107. W. Crosskill, Beverley, York—Improvement in the construction of carriage-wheels to run on railways and ordinary roads.
108. E. Highton, Regent's-park—Improvements in suspending the wires of electric telegraphs.
109. H. Holland, Birmingham—Improvements in the construction of parts of umbrellas and parasols.
110. R. Maclaren, Glasgow—Improvements in moulding or shaping metals.
111. H. Corlett, Summer-hill, Dublin—Improvements in springs for railway and other carriages and vehicles.
112. K. Weber, Rechtburg, Wurtemberg—Improvements in the manufacture of boots and shoes.
113. B. G. Sloper, London—Improvements in machinery or apparatus for separating gold from earthy matters.

*Dated January 18.*

114. W. B. Haigh, Oldham, Lancaster—Improvements in machinery or apparatus for tenoning, mortising, slotting, cutting, or shaping wood or metal.
115. E. Lord, Todmorden, York—Improvements in looms for weaving.
117. C. S. Cahill, Greenwich, and Annadown, Ireland—Improvements in submarine, subterranean, and other electric and magnetic telegraphs, and in insulating, laying down, joining, and covering the same.
118. W. Batten, Westbourne-street, Pimlico—Improvement in the construction of a sink, drain, or gulley trap, named the Self-Acting Effluvium Trap, for the more effectual conveyance of all liquids or admixtures in passing into drains, sewers, cesspools, or other receptacles, and the better prevention and exclusion of all vapours, effluvia, or gases arising therefrom.
119. W. Greenshields, Edinburgh—Improvements in chenille fabrics.
120. W. Thomas, Cheapside—Improvements in stays.
121. E. Sharpe, Swadlincote Potteries, near Burton-on-Trent—Improvements in the apparatus used for sifting clay.
122. C. Howard, Trafalgar-terrace, Hoxton—Improvements in the manufacture of iron.
125. J. P. Bourquin, Newman-street—Improvements in or applicable to troughs or vessels for holding liquid substances required in the art of photography.

*Dated January 19.*

127. G. H. Bursill, Offord-road, Islington, and Ranelagh Works, Pimlico—Improvements in operating upon metalliferous ores and other minerals, and upon slags and sweep, in order to facilitate the separation and recovery of the metals and other products; also in machinery or apparatus for effecting such improvements, which is in part applicable to other purposes.
128. A. Dalgety, Florence-road, Deptford—A new construction of rotatory engines or pumps.
129. J. Norton, Cork—Improvements in effecting communications between the different parts of railway trains.
130. T. Webb, Platt's Glass Works, Stourbridge—Improved apparatus applicable to the annealing of glass and the firing of pottery ware.
131. H. Guyon, Paris—Improvements in the manufacture of bread.
132. H. Brownentt, Liverpool—Treating scrap and waste iron, so as to render the same more readily available in the manufacture of iron.
133. F. Parkes, Sutton Coldfield, Warwick—Mode or method of fixing tools and implements in helves or handles.
134. N. Hunt, Massachusetts, U. S.—Improvements in machinery for sewing cloth or other material. (A communication from C. Hodgkins, Massachusetts.)
135. C. W. R. Rickard, Great Charlotte-street, Blackfriars-road—Improvements in cocks and taps.

*Dated January 20.*

136. H. Dircks, Moorgate-street—Improvements in safety-apparatus, applicable to certain boilers and stills.
137. H. B. Condy, Battersea—Improvements in the manufacture of sulphate of soda, sulphate of potash, and other sulphates, and in the manufacture and employment of muriatic acid.
138. E. Aitchison, Manor-street, Chelsea — Improvements in apparatus for fixing, removing, and plugging tubes of tubular steam-boilers.
139. A. E. L. Bellford, Castle-street, Holborn—Improvements in cutting out cloth and other fabrics and materials suitable for garments and furniture. (A communication.)
140. O. R. Chase, Boston, U. S.—Pulverising machinery.
141. J. J. Field, Charles-terrace, Islington — Improvements applicable to guns, cannon, or ordnance, rifles, and other similar implements of war or the chase, for more accurately aiming at the object to be struck by projectiles.
142. R. S. Smith and A. MacDougall, Manchester—Improvements in treating, deodorising, and disinfecting sewage and other offensive matter, which said improvements are also applicable to deodorising and disinfecting in general.
143. J. H. Johnson, Lincoln's-inn-fields—Improvements in the manufacture of stays or corsets. (A communication from A. G. Geresme, Paris.)

*Dated January 21.*

144. R. Roberts, Manchester—Improvements in machinery for cutting paper, pasteboard, leather, cloth, and other materials.
146. M. L. L. Beaudeloux, Paris—A candlestick working by machinery, so as to keep the candle always at the same height in a tube, with a shade of a peculiar construction, so as to augment greatly the quantity of light.
148. G. Grace and T. F. Jones, Birmingham—Improvements in boots and shoes, as also boot and shoe socks or inner soles, whereby the same are rendered waterproof.
149. J. Westerton, Earl's-court-road, Brompton—Improvement in the manufacture of night-light boxes or cases.
150. C. M. T. du Motay, Rue Fontaine St. George, Paris—Improvements in the manufacture of oil from rosin.
151. H. E. Falcke, Gateacre House, Liverpool—Improvements in preparing or manufacturing salt.
152. T. B. Venables, Burslem, Stafford—Improvements in the manufacture of earthenware.
153. P. Spence, Pendleton, near Manchester — Improvements in manufacturing the prussiates of potash and soda.
154. D. Warren, Exmouth—Improvements in raising, pumping, or forcing water.
155. C. J. Edwards, Great Sutton-street—Improvements in the manufacture of bands for driving machinery.

*Dated January 23.*

156. A. Shanks, Robert-street, Adelphi—Improvements in machinery for punching and shearing metals.
157. C. C. Armstrong and W. Pursall, Birmingham—New or improved percussion-cap.
158. W. Darling, Edinburgh—Improvements in sewing-machines. (A communication.)
160. T. Robinson, Farringdon-street—Improvements in apparatus for filtering volatile liquids.
161. M. A. Muir, Glasgow—Improvements in weaving.
162. J. Lockhart, jun., Paisley, Renfrew—Improvements in the manufacture of bobbins.
163. J. G. Taylor, Glasgow—Improvements in treating the fleeces or natural coverings of sheep and other animals, when on the animals.
164. J. G. Taylor, Glasgow—Improvements in lamps, and in substances to be burned therein.
165. H. Seebohm, Eshol, near Leeds—Improvements in combing wool, goats'-hair, alpaca, cotton, and other fibrous material.
166. J. Getty, Liverpool—Improvements in the manufacture of tubular bridges; part of which improvements is applicable also to the preparation of plates for covering iron ships, for constructing boilers, and for other analogous uses.
167. J. Westlake, Totnes, Devon—Pulverising, washing, separating, amalgamating, and otherwise treating ores, gossans, earths, and rocks, so as the better to obtain and extract therefrom the gold and other metals and minerals which may be contained therein.
168. A. E. L. Bellford, Castle-street, Holborn—Improvements in machinery for bending metal, and producing forms thereon by pressure. (A communication.)
169. J. M. J. L. Bouvet, Boulevart St. Martin, Paris—Improvements in kneading-machines.
171. R. A. Brooman, Fleet-street—Improvements in machinery for sawing stone and marble. (A communication.)
172. R. A. Brooman, Fleet-street—Improvements in extracting copper from the ore. (A communication.)
173. A. T. Wagner, Berlin—A psycograph or apparatus for indicating persons' thoughts by the agency of nervous electricity.

*Dated January 24.*

174. A. W. Sleigh, Weymouth-street, Portland-place—Creating a continual self-acting, self-sustaining new motive power, applicable to every purpose requiring speed, motion, and power, together or separately.
175. G. Williams, Cannon-street, St. George's-in-the-East—Improvements in the construction of waterclosets.
176. J. B. Monier, La Villette, Paris—A new chemical process for the production of sulphates of soda, potassa, and alumina, of nitrates of soda and potassa, of soap, and of hydrochloric, sulphuric, stearic, morgaric, and elaidic acids.
177. J. L. Schlossmaker, Paris—Improved support of lamps.
178. J. Ridgway, Cauldon-place, Stafford—Improvements in the method of generating and applying heat to kilns, ovens, and furnaces, for manufacturing purposes.
179. W. I. Ellis, Salford, Lancaster—Improvements in turntables to be employed on or in connection with railways.
180. W. Massey, Hemer-terrace, near Liverpool—Improvements in artificial teeth and gums.
181. J. Bapty, Leeds—Improvements in machinery for preparing to be spun wool and other fibrous substances when mixed with wool.
182. S. C. Lister, Manningham, Bradford—Improvements in combing wool, cotton, and other fibrous materials.
183. J. Bird, Oak Farm, near Dudley—Improvements in kilns for burning bricks and other articles.

*Dated January 25.*

184. J. A. Mingaud, St. Pons (Herault), France—Improvements in producing ornamental surfaces on velvet or other hairy cloths or fabrics.

185. E. B. Walmsley, Middle Mall, Hammersmith—Improvements in utensils, implements, and apparatus for the purposes of lighting, heating, and cooking.
186. W. E. Newton, Chancery-lane—Improvement in violins and other similar stringed musical instruments. (A communication.)
188. W. H. Thornthwaite, Newgate-street—Improvement in the manufacture of sulphuric acid.
189. R. A. Brooman, Fleet-street—New and improved fluid for illuminating purposes. (A communication.)
190. A. L. Reid, Glasgow — Improvements in printing textile fabrics and other surfaces.
191. J. Anderson, Auchnagie, Perth—Improvements in obtaining motive power.

*Dated January 26.*

192. T. Wicksteed, Leicester—Improvements in the manufacture of sewage-manure.
193. T. Wicksteed, Leicester—Improvements in the manufacture of sewage-manure.
194. T. Wicksteed, Leicester—Improvements in the manufacture of sewage-manure, and in apparatus for that purpose.
195. F. M. Blyth, Norwich—Improvements in the mode of heating water for steam-boilers.
196. C. Reeves, jun., Birmingham, and W. Wells, Sutton Coldfield, near Birmingham—Improvement or improvements in casting metals.
197. S. Smith, Hyson Green Works, near Nottingham—Improvements in valves or apparatus for regulating the passage and supply of fluids.
198. S. S. Stallard, York-street, Leicester—Improvements in the manufacture of knit fabrics.
199. G. Firmin, Bath—Improvements in anchors.

*Dated January 27.*

200. F. F. Rohart, Sotteville les Rouen, France—Improvements in the preparation of a certain substance for clarifying liquids.
201. P. M. Crane, Canonbury-villas, Islington—Improvement in the manufacture of iron.
202. A. C de Simencourt, Paris—Improvements in composing and distributing type.
203. W. Church and S. A. Goddard, Birmingham—Improvement or improvements in ordnance.
204. H. Tendall, Hoxton, and W. S. Trotter, London—Improvements in machinery and apparatus for crushing, washing, and amalgamating auriferous quartz and other ores.
205. T. Thurlby, Guildford-street East, Spafields—Improvements in the means of effecting instant communication between distant points of railway trains.
206. W. Palmer, Brighton—Improvements in the manufacture of materials for and in constructing houses and other buildings.
207. W. Partington, Bolton-le-Moors, Lancaster—Improved construction of safety-valve for steam-engines.
208. J. Atkinson, Richmond-grove—Improvements in thrashing machinery.

*Dated January 28.*

209. J. J. L. Fournier, Montpelier, France—Improved mode of obtaining alcohol.
210. J. Grist, New North-road, Islington—Improved break for railway and other carriages.
211. M. T. Raymond, Clement's-lane, Lombard-street—Improvements in apparatus for retarding and stopping trains of carriages on railways
212. J. L. Clark, Canonbury-villas, Islington—Improvements in apparatus for conveying letters or parcels between places by the pressure of air and vacuum.
213. W. Williams, Cheapside—A method of, and apparatus for heating the heaters of box-irons and other like purposes.
214. D. Chadwick, Salford, Lancaster, and G. Hanson, Manchester—Improvements in meters for measuring water or other liquids, and vapours or gas.
215. D. Bethune, Toronto, Canada West—Improvements in the construction of vessels propelled by steam or other motive power.
216. W. G. Taylor, Norfolk-terrace, Westbourne-grove—Improvements in certain parts of machines employed for preparing and spinning cotton, wool, hair, silk, flax, and other fibrous substances or materials.
217. W. Woolford, Bowling New Dye Works, Bradford—Improvements in pressing and watering moreens and other fabrics.
218. W. Redgrave and T. Redgrave, Bow-street, Covent-garden—New railway signal-lights, to be called "Redgrave's Patent Railway Signal-Light."

*Dated January 30.*

219. P. A. L. de Fontainemoreau, South-street, Finsbury—Improved means of preventing accidents on railways. (A communication.)
220. P. A. L. de Fontainemoreau, South-street, Finsbury—Certain arrangements for preventing accidents on railways. (A communication.)
221. H. J. Iliffe and N. Brough, Birmingham—Improvements in the manufacture of buttons, and in attaching them to articles of wearing apparel.
222. W. Phillips, Birmingham—Improvements in the manufacture of coffins.
223. W. Hodgson, Wakefield, York—Improvements in machinery for the manufacture of looped fabrics.
224. B. O. Stratford, Earl of Aldborough, Stratford-lodge, Wicklow—Improvements in aerial navigation.
225. J. R. Cooper, Birmingham—Improvements in preparing or constructing and dressing rolls for rolling gun-barrels, tubes, and bars.
226. R. Garrett, Leiston Works, Suffolk—Improvements in thrashing-machines.
227. J. Kershaw, Dublin—Improvements in steam-engines.
228. J. H. Johnson, Lincoln's-inn-fields—Improvements in the manufacture or production of gas, and in the application of the materials employed therein. (A communication from A. Koechlin, N. J. V. Duchatet, and J. A. A. de Perpigna.)
229. R. Chapman, Eaton, Norwich—Apparatus for regulating the feed to millstones.

*Dated January 31.*

230. T. Cox, Wolverhampton—Improvement or improvements in buttons, and in attaching the same to articles of dress.
231. A. M. Fatio and F. Verdeil, Paris—Improvements in preserving animal and vegetable substances.
232. E. W. K. Turner, Praed-street, Paddington—Treating gold and other ores.
233. T. Hollingsworth, Nottingham—Improvements in forming or applying tags to laces.
234. L. Young, Bow-lane, Cheapside, and E. Marten, Louisa-street, Stepney—Improvements in apparatus for regulating the pressure and supply of gas.
235. C. Erckmann, La Villette, near Paris—The manufacture of telegraphic wires.
236. I. Hazlehurst, Ulverstone, Lancaster—Improvements in the manufacture of iron by blast, and in the construction of furnaces and machinery for the same.
237. R. Oliver, R. Barlow, and J. Blundell, Manchester—Improvements in machinery or apparatus for embossing and cutting out patterns or devices for the ornamentation of textile fabrics or other materials or surfaces.
238. L. C. Koeffler, Rochdale, Lancaster—Improvements in machinery or apparatus for preparing, dressing, and finishing yarns or threads.
239. L. Koeffler, Rochdale, Lancaster—Improvements in the method or process of scouring, washing and oiling wool and other textile materials, for the purpose of spinning, and in the machinery or apparatus connected therewith.
240. W. Wright and G. Brown, Newcastle-upon-Tyne — Improvements in cupolas; which improvements are also applicable to smelting and other furnaces.
241. P. J. Meeus, Paris—Improvements in producing metallic surfaces.
242. W. Malam, Blackfriar's-road—Improvements in apparatus for the manufacture and holding of gas.
243. R. A. Brooman, Fleet-street—Improvements in the manufacture of steel. (A communication.)
244. P. Beudot, Boulevart St. Martin, Paris—Improvements in gas-burners.
245. J. Jackson, Broad-street, Golden-square, and G. M. Hantler, Sloane-street—Improvements in baths.

*Dated February 1.*

246. C. B. A. Chenot, Boulevart St. Martin, Paris—Improvements in accumulating, conducting, and treating gases of combustion, and also in generating and applying the same to metallurgic and other purposes.
247. H. Wickens, Tokenhouse-yard—Improvements in the mode of intercommunication in railway trains.
248. A. Motera, Paris—Improvements in apparatus for stopping locomotive engines, wagons, or other vehicles on railways.
249. J. Buchanan, Leamington Priors, Warwick—Improvements in propellers, and in applying them.
250. J. Burgum, Birmingham—New or improved self-acting damper for the furnaces of steam-boilers.
251. W. Guest, Lion-square, Nottingham—Improvements in machinery for making whips; parts of which improvements are also applicable to the manufacture of braids and wire-nets.
253. A. Robinson, Whitehall-place—Improvements in preparing compositions for coating iron and other ships' bottoms and other surfaces.
254. C. F. Le Page, Paris—Improvements in apparatus for lighting.
255. J. Jobson, Litchurch Works, near Derby, and R. Jobson, Holyhall Works, near Dudley—Improvements in the manufacture of moulds for casting metals.
256. A. Daniel, Moorfields, Wolverhampton—Improvements in locks, and in handles for the same.
257. J. Hargreaves and J. Fletcher, Facit, near Rochdale—Improvements in machinery for preparing to be spun cotton and other fibrous materials.
258. J. D. Morrison, Sunderland—Improvements in winches.
259. J. Beattie, Lawn-place, Lambeth—Improvements in furnaces, and in the treatment of steam.

*Dated February 2.*

260. T. Atkins, Oxford—Improvements in transmitting power and communicating motion to implements for agricultural and other purposes.
261. A. Mohler, Obernay (Bas Rhin), France—Improvements in apparatus for lubricating machinery.
263. C. E. Paris, Paris—Improvements in covering with metals certain metallic surfaces.
264. J. Stevens, Darlington Works, Southwark-bridge-road—Improvements in apparatus for giving railway-signals.
265. J. H. Glassford, Glasgow—Improvements in lithographic and zincographic printing.
266. F. H. Sykes, Cork-street, Piccadilly—Improved apparatus for supplying or feeding boilers with water, applicable to raising and forcing liquids for other purposes.

*Dated February 3.*

268. A. E. L. Bellford, Castle-street, Holborn—New system of apparatus, to be called "Atmospheric Post," for transmitting letters and messages, and applicable to railways, and as a speaking-trumpet. (A communication.)
270. R. B. Newhouse, Uckfield, Sussex—Improved apparatus for conducting off the gases of combustion from open fireplaces.
272. A. Lannes, Marquis of Montebello, Mareuil-sur-Ay, France—Improved propeller, applicable to the navigation of ships and other vessels.
274. E. Howard and D. P. Davis, Massachusetts, U. S.—Improvements in machinery for sewing cloth or other material. (A communication by S. H. Roper, Massachusetts.)

*Dated February 4.*

276. W. Gosling, Edward-street, Woolwich—An invention for the purpose of preventing collisions on railways, which he has designated "Gosling's Railway Danger Signal."
278. A. V. Newton, Chancery-lane—Improvements in springs applicable to railway carriages and other uses. (A communication.)
280. W. Little, Strand—Improvements in distilling or obtaining products from coals and bituminous substances.
282. E. Cole, Hemming's-row, Westminster—Improvement in the frames of travelling-bags.

*Dated February 6.*

284. D. Deyres, Bateman's-buildings, Soho-square — Improvements in drilling and boring.
288. T. and W. Hemsley, Melbourne, Derby—Improvements in the manufacture of looped fabrics.
290. A. Duncan, Glen House, Stirling—Improvements in bleaching.
292. P. Trumble, Huddersfield—Improvements in paperhangings.

*Dated February 7.*

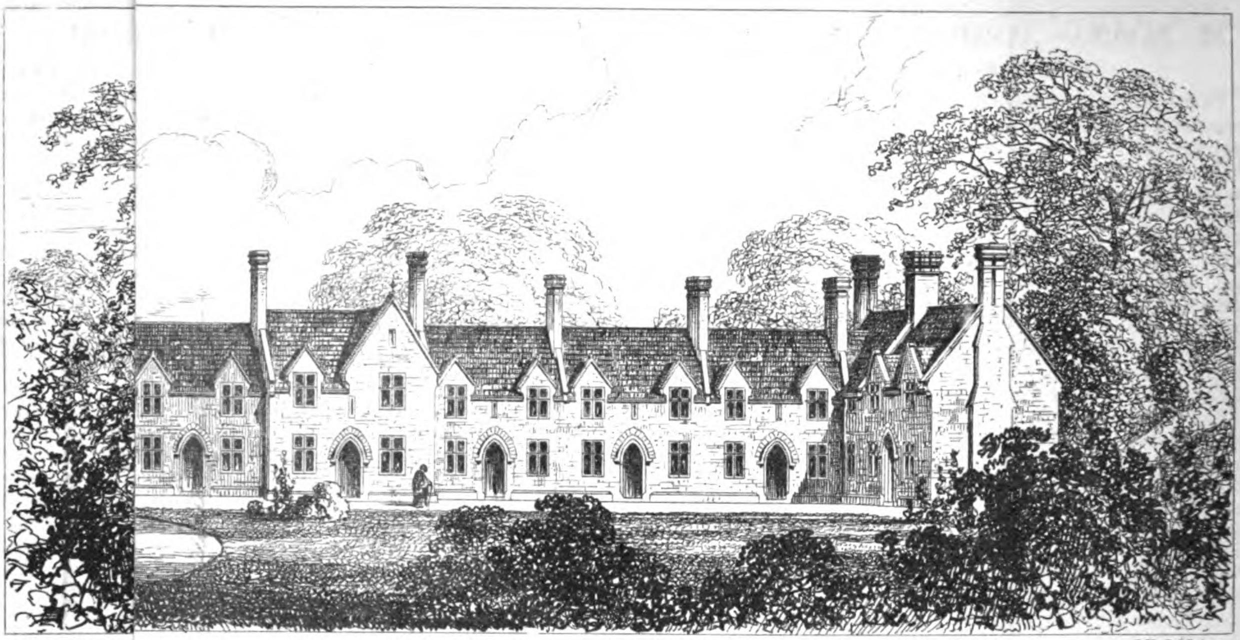
294. J. Murdoch, Staple-inn, Holborn—Improved process for manufacturing paper. (A communication.)
296. E. Poitiers, Malden-terrace, Haverstock-hill—A new material for the manufacture of cordage, canvas, and linen, and generally as a substitute for hemp and flax.
298. W. J. Curtis, Birchin-lane—Improved railway-signal, especially adapted as a danger-signal.
300. A. F. D. Duvillier, Rue du Bouloi, Paris—New system of remontoirs, or apparatus for winding up watches without a key.
302. J. Taylor and I. Brown, Carlisle, and J. Brown, Oxford-street—Improvements in the charring of vegetable and animal substances.
304. A. V. Newton, Chancery-lane—Improved machinery for heckling flax and other fibrous materials. (A communication.)

*Dated February 8.*

306. E. T. Rees, Prospect-place, Swindon—Improvements in pressure slide-valves in steam-engines, to be called the "Anti-Pressure Valve."

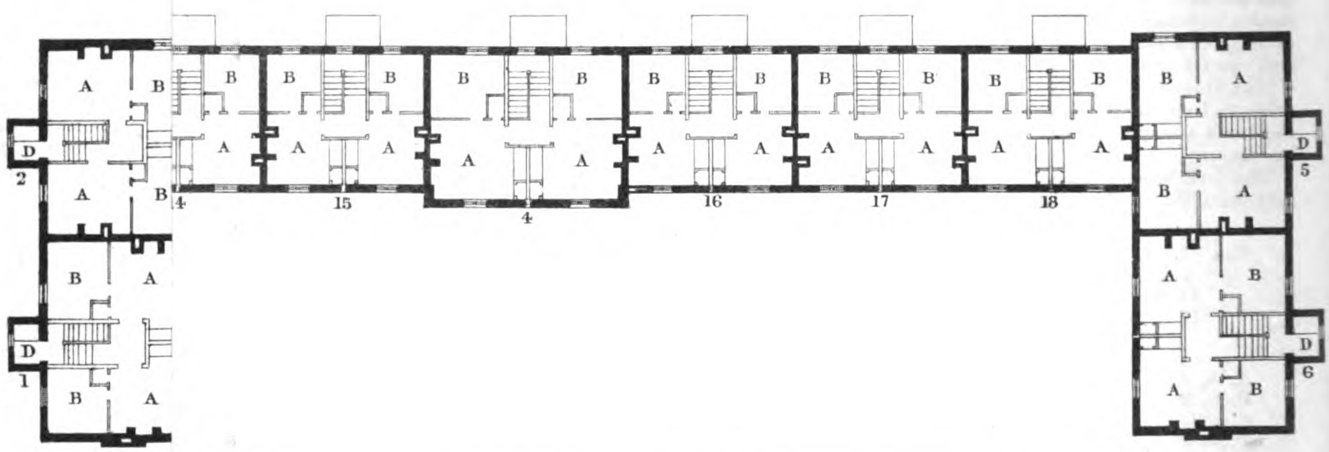
## PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

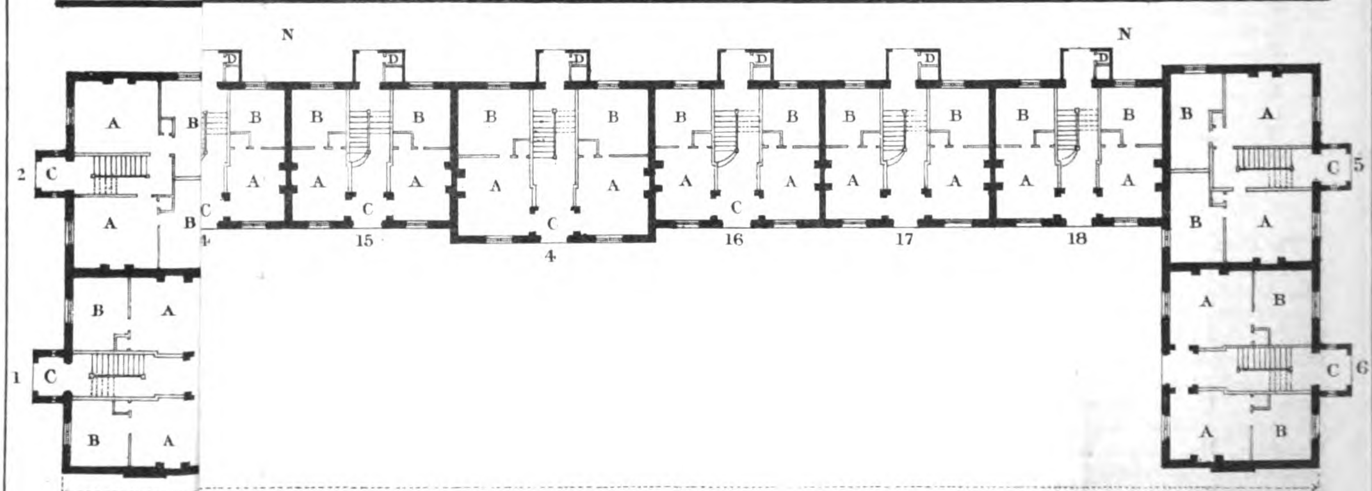
147. H. Watson, High-bridge, Newcastle-upon-Tyne—Improvements in waterclosets. —Jan. 21.
252. F. H. Wenham, Effra Vale Lodge, Brixton—Improvements in fire-arms.—Feb. 1.
286. R. J. Maryon, York-road, Lambeth—Improvements in the machinery for the improved construction of windlasses and other machines for which the same invention is applicable.—Feb. 6.
319. J. Taggart, Massachusetts, U. S.—Improved machine for excavating earth—Feb. 9.



J.R. Jobbins.

FTON PLACE, KENTISH TOWN.



## ST. PANCRAS ALMSHOUSES, KENTISH TOWN.

(*With an Engraving, Plate* XV.)

These Almshouses have been instituted by subscribers in the large and populous parish of St. Pancras, and are intended to receive those residents in the parish who from misfortune may, in their old age, have fallen into indigent circumstances. The inmates are elected by the whole body of the subscribers, and, to render them eligible, they must have paid poor-rates in the parish for not less than ten years, have borne a good character, never received parochial relief, and be upwards of sixty years of age. The centre building, with offices in the rear, and six of the houses, have already been erected, and are partly occupied. The committee are appealing to the sympathies of the benevolent to enable them to complete the remainder of the houses, and they intend holding a Fancy Sale in May or June next, for the benefit of the Institution, at the Colosseum, Regent's-park.

The Almshouses when completed will have a clear southern aspect of about 400 feet, and will form one side of a square to the north of the Governesses' Institution, and adjoining Grafton-road, Kentish-town. When completed, there will be eighteen houses, besides the centre building, which contains the board-room, secretary's-office, &c., as well as apartments for two married couples, who will be entrusted with the general superintendence of the whole. The eighteen houses consist of six for unmarried females, six for unmarried men, and six for married persons. Each house for the unmarried contains four persons, the apartments for whom are distinct and separate; each set of apartments is fitted up with living-room, separate place for bed, a properly-ventilated safe, coal closet, sink constantly supplied with water, as well as provision for taking away all refuse water. The houses for married persons each contain four couples, and except that an additional amount of room is provided, they are similar to the houses for the unmarried persons, and are fitted up in a like manner. In addition to this, there is at the back of the centre building a washhouse and laundry for the use of the whole of the inmates. There is also provided a bath-room for males, and one for females, to be supplied with hot and cold water.

The Houses externally have a picturesque and pleasing appearance, and are in the simple Old English style. The walls are of red brick and stone, relieved by diamond-work in darker-coloured bricks.

The builders are Messrs. Hopkins and Roberts, of Islington; and the architect, Mr. James K. Colling.

*References to Engraving.*

Nos. 1, 2, 3, 4, 5, 6 ... Houses for married persons.
,, 7, 8, 9, 10, 11, 12 ... Houses for unmarried women.
,, 13, 14, 15, 16, 17, 18 .. Houses for unmarried men.
,, 19 ... Centre building, containing board room, &c., and apartments on the ground story for two married couples.

A, A, A ... Living-rooms.
B, B, B ... Bed-rooms.
C, C, C ... Entrance porches.
D, D, D ... Waterclosets.
E ............ Wash-house.
F ............ Laundry.
G, G ......... Coals.
H ..... ...... Bath for females.
I ............ Bath for males.
K ............ Board room
L ............ Secretary's office.
M ............ Waiting room.
N ............ Back yard, with dust-bins (fitted with cinder-sifter) and coal stores for every house.

*The Conical Flour Mill.*—Since we noticed this valuable invention, it has been making rapid progress both at home and abroad. The Austrian patent has been sold for 30,000*l.* A large mill has been erected at Vienna, and is in full work. Another has been built for Lord Portman, at Bryanstone, Dorset, which grinds 8½ bushels per hour against an ordinary mill belonging to his lordship which grinds 2½ bushels, and the same power (water) does for both. The magistrates of Hampshire are erecting a mill in the county gaol at Winchester, and in Ireland Lord Talbot de Malahide, Mr. Dargan, and others take a lively interest in its adoption in that country. In France, Prince Murat has become the president of a committee to carry it out.

## THE ACROPOLIS OF ATHENS.*

The City of Athens was founded on an isolated rock in the midst of a plain. Originally this noble city, from which we derive all those arts and sciences which have illustrated the nations of Europe, was comprised within the natural and artificial fortifications which encircled the table land on the summit of the rock. The city did not for a considerable period exceed these limits. As the number of inhabitants increased, however, they built houses at the foot. The top of the hill, which the fortifications rendered a citadel, may be considered the more important portion of the city; and around the temple which was raised to Minerva, the patron of Athens, many other temples were successively erected. Statues of divinities and heroes, and inscriptions of every kind, were added. It was there, at the top of this impregnable rock that were celebrated the religious festivities of the people.

The rock on which the Acropolis reposes presents the appearance of a very irregular oval. On the north, east, and south it is too steep and high to be climbed, and it is only on the western side that a less abrupt descent gives access to the citadel. At the upper part of this declivity are the outer gates, the object of which had not been accurately determined until Mons. Beulé discovered a range of steps parallel to the front of the outer gates, and as wide as the principal body of the edifice. The destination, then, of the gates (Propylæa) has been ascertained,—after having mounted the immense stairs in question, this open portico formed the entrance to the Acropolis. Mons. Beulé attributes this grand and beautiful construction to Mnasicles, the builder of the Propylæa, and he is borne out apparently by the disposition and inclination of the ground compared with the site of the Propylæa. He considers, that although the plan (extremely original) of the gates is not in accordance with the traditional laws which were so religiously observed by the Greek architects, the details of the edifice, as pure as those of the Parthenon, prove that it was constructed during the most flourishing epoch of art.

Passing over the attacks and troubles to which it was previously exposed, Xerxes, after having ravaged the Peloponnesus, laid seige to Athens in the year 479 B.C., and the inhabitants having left the city with the exception of some old people who still remained, he set fire to all the edifices which covered the Acropolis. Mardonicus, master in his turn of Athens, succeeded in annihilating what Xerxes had been only able to leave in ruins. According to the testimony of Herodotus, he left neither a wall of the city nor a house standing; and even at the present day fragments of ancient temples are found, broken marble, blackened stones, coal, earthen and metal vases, all bearing witness to a devastation the traces of which twenty-four centuries have not been able to conceal.

There doubtless existed an ancient Parthenon, built by the tyrant Pisistratus, but of which there is no mention made in the ancient authors, so much had it been thrown in the shade by that which the architect Ictinus constructed during the government of Pericles.

The Acropolis of Athens, a spot considered sacred by the inhabitants, inspired even foreigners with such respect, that when it was taken by the conqueror Scylla, he stopped the pillage, and merely caused the town and citadel to be dismantled. Even when the rest of Greece was despoiled of its masterpieces of art, those of Athens were considered inviolable. Athens was not treated as a conquered city, but as the mother country of the conquerors;—Julius Cæsar forgave its fidelity to Pompey; Antony, its adhesion to the party of Brutus and Cassius; Augustus, the favours it had received from Antony. It was Nero who commenced the work of devastation. When he had depopulated Delphos and Olympus of their statues, he carried off the greater part of those which stood in the Acropolis of Athens. Before the close of the fourteenth century, the first Duke of Athens, Neri dei Acciajuoli, transformed the Propylæa into a palace, which he surrounded with fortifications, and of which he destroyed in all probability a considerable part, so as to change it into a princely habitation according to the ideas of the age.

Up to this period, the exterior of the edifice was in a good state of preservation, but the taking of Athens by Mahomet II., about 1456, and the effect of artillery already in use at this time, resulted in an almost complete destruction of the monuments of the Acro-

* Abridged from the French of Delécluse.

polis. Although the lords of Athens had previously erected numerous fortifications, it was necessary to strengthen them still further, in order to make the Propylæa, now the habitation of the Aga, and the only accessible point, secure from artillery which might be brought to bear against that structure. An immense bastion was therefore constructed in front, the approaches to the citadel were shut by a line of walls and gates, and the ancient towers and walls were buried 40 feet underground. The Parthenon became a mosque, the Erechtheion a harem, and, in their aversion to images, the Turks mutilated every piece of sculpture that came within their reach. In 1656, on the eve of a great festival the Turks wished to celebrate, the Aga Joussouf took it into his head to destroy the church of St. Dimitri, which is built in the plain at the foot of the Museion. With this object in view, he had three pieces of cannon planted, and ordered his soldiers to be ready on the following morning at break of day. This Joussouf lived in a great dome, constructed under the principal vestibule of the Propylæa, which was used at the time as a depôt of arms and powder-magazine. During the night a thunderbolt fell on this little arsenal, which exploded, and blew up the Aga and his whole family.

The invention of gunpowder has been fatal to the monuments of the Acropolis. Thirty-one years after the above event, the Venetians, who had just taken possession of the Morea, menaced Athens. The Turks, determined to make a vigorous defence, immediately set to work with the intention of fortifying still further the Acropolis, and constructing batteries, one of which has been elevated on the the ruins of the Temple of Victory, which indeed they ruined for the purpose. The Venetians, however, landed at the Piré, and the Count of Konigsmark, lieutenant of Morosini, planted his mortars on the hills which surround the western side of the Acropolis. The bombarding commenced on the 26th September 1687. The Parthenon, which commanded the platform on this side, and in which the Turks had shut up their families, was more particularly aimed at. The Turks had also placed in it all their most valuable effects and a large quantity of gunpowder. The bombs themselves would not have penetrated the solid roofing of the Parthenon, but sparks having got into the structure, the powder took fire, and the Parthenon blew up on the evening of the 28th September. Almost all the cella and its frieze, eight columns of the northern portico, and six of the southern portico with their entablatures, were overthrown,—the vast temple was cut, as it were, into two masses of ruins. The Turks, terror-stricken, surrendered the following day, and Morosini entered in triumph the Acropolis. By his orders the horses and car of Minerva, in such admirable preservation that the most indifferent traveller spoke of them with enthusiasm, were carried away; but the work was so badly conducted, that the whole group fell, and was shattered on the rock. The captains of Morisini followed the example of their chief, and fragments of the Parthenon, according to the testimony of Brönstedt, were carried even to Copenhagen.

Up to the end of the eighteenth century, the work of destruction may be considered as resulting from the exigencies of war, or the ignorance and apathy of the successive guardians of these precious remains. But when a taste for the works of antiquity began to spread throughout Europe, a new species of barbarism developed itself—a learned vandalism, which has taken from the principal monuments of Athens ornaments which had until then escaped destruction.

A piece of the frieze of the Parthenon—one only, and detached this long time, having belonged to the eastern side, entirely ruined a hundred years ago—was brought to France by the Comte Choiseul-Gouffier, on his return from an embassy to Constantinople. This served as a precedent to Lord Elgin in 1810 for carrying off more than 200 feet of the frieze of the Parthenon, and almost all the statues of the pediments. Besides, the metopes were torn from their grooves, the triglyphs and cornices were broken in pieces by the hammer, their fragments of architecture, capitals, entablatures, &c., were taken away. The Propylæa also furnished specimens; two sides of the frieze of the Temple of Victory without Wings did not escape; the Temple of Erechtheus was pillaged, and one of the statues which supported the portico of the Caryatides was carried off, at the risk of the whole portico falling to the ground.

These are the principal vicissitudes of the Acropolis of Athens during the two thousand two hundred and eighty-nine years which have elapsed from the destruction of this famous citadel by Xerxes to the carrying off the marbles by Lord Elgin. But not to omit any, it should be mentioned, that in the war of independence the Acropolis, where the Turks and Greeks alternately besieged one another, was still the scene of disasters, for at this period the cannon mutilated its marbles and overturned a part of the Erechtheion.

F. P. H.

## ON THE STRENGTH OF COMPOUND GIRDERS.

By Homersham Cox, M.A., Fellow of the Cambridge Philosophical Society, Barrister.

The recent publication of Mr. Fairbairn's interesting and valuable work, 'On the Application of Cast and Wrought Iron to Building Purposes,' affords a suitable occasion for reviewing some of the principles adopted in designing iron beams and girders of various forms. The diversities of opinion which exist respecting the relative merits of the modes in which iron is now most usually applied to constructive purposes, constitute a sufficient excuse for entering on the proposed inquiry.

The subject of the strength of simple beams, or those in which the whole of the material forms a single mass without joints or apertures, has been sedulously investigated both experimentally and mathematically: but the investigation of the strength of compound beams, consisting of several distinct parts connected by joints or otherwise, is comparatively incomplete. Such structures are now used to a great extent in modern engineering. My inquiries have led me to the conclusion that, notwithstanding the great importance of sound mechanical principles in forming such structures, some of the most common of them have been designed without sufficient knowledge of the strains to which they are subject.

### Trussed Cast-Iron Girders.

The first form of compound girder which I purpose to consider is the *Trussed Cast-Iron Girder*, represented in the accompanying diagram, copied from that given at page 32 of the work just mentioned. This girder is a single beam of the well-known form

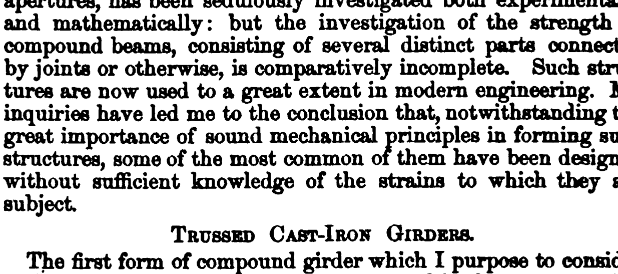


Fig. 1.

of section $a' b'$, modified by the addition on both sides of it of wrought-iron tie-rods A B, C B, connected to the upper part of the beam at its extremities, and meeting under it at B below the centre. Mr. Fairbairn is of opinion that in this truss-beam the two materials, wrought-iron and cast-iron, cannot be brought to act in perfect concert with each other, and that in order that the materials may be most economically disposed, the cast metal ought to be upon the point of rupture at the same time that the truss-rods are about to yield by extension. The difficulties of obtaining this perfect adjustment are two-fold—those arising from the different elasticity of the two metals, and those arising from their different expansibility by heat. These difficulties are well expressed by Mr. Fairbairn in the following laws, which he deduces from experiment.

1. Within the limits of 6 tons tensile strain per square inch for cast-iron, and $13\frac{1}{2}$ tons for wrought-iron, the tensile force applied to wrought-iron must be $2\frac{1}{4}$ times the tensile force applied to cast-iron in order to produce equal elongations.

2. For tensile forces below $7\frac{1}{2}$ tons per square inch the *set* of cast-iron is far greater than that of wrought-iron; but for tensile forces above 15 tons per square inch, the set of wrought-iron is much greater than the maximum set of cast-iron.

3. The elongation by 90 degrees of heat of a bar 10 feet long of wrought-iron is ·0067 of an inch more than the corresponding elongation ot wrought-iron: and from the last law Mr. Fairbairn infers that this difference of elongation is equivalent to a tensile force of $\frac{3}{4}$ths of a ton per square inch.

I shall occupy this paper with the consideration of the operation of the *first* of these laws as it affects trussed girders. The adjustment of truss-rods is investigated by Mr. Fairbairn as follows:—

"*First.* Let us consider the case, when the truss-rods have no strain upon them at the time the beam is unloaded. Suppose the beam to be loaded so as to produce a tensile strain upon the cast-iron equal to one-third its breaking-load, that is to say, let the force of elongation be $2\frac{1}{4}$ tons per square inch upon the cast metal; then, from Table III., we find that the strain upon the truss-rods will be about $5\frac{1}{4}$ tons per square inch, and that the set of the cast-iron, after these strains are taken off, will be 6 times that of the wrought-iron. Now, in this case, while the cast-iron is strained to one-third its breaking-weight, the wrought-iron is strained to only about one-fifth its ultimate strength; and, further, when the load is taken off, the cast-iron beam will remain much more elongated than the iron rods, which will, to a certain extent, destroy their original adjustment of tension, but this, in the present case, will not act unfavourably, for it will tend to give a certain amount of tension to the truss-rods.*

"Suppose the beam to be loaded so as to produce a tensile strain upon the cast-iron equal to $5\frac{1}{4}$ tons per square inch; then, in order to produce an equal elongation of the truss-rods, the strain upon them must be $2\frac{1}{4}$ times $5\frac{1}{4}$ tons, or $12\frac{1}{4}$ tons nearly. Here, while the cast-iron is strained to more than two-thirds its ultimate resistance, the wrought-iron is only strained to about one-half its ultimate resistance. One favourable circumstance connected with this load is, that the sets of the two metals are very nearly the same.

"Suppose the beam to be loaded so as to produce a tensile strain of 15 tons per square inch upon the truss-rods, then, by Table II, this will produce an elongation of $\frac{1}{470}$ part of the length of the rod; but, by Table IV., the ultimate elongation of cast-iron is $\frac{1}{550}$ part of its length; therefore the cast-iron would be ruptured by extension some time before the truss-rods could arrive at a strain of 15 tons per square inch, that is, before they could be strained to two-thirds their ultimate strength.

"This adjustment is defective: the truss-rods must obviously have a certain amount of tension before the load is laid on, in order to bring them into a higher condition of action, and to counteract the set of the cast metal.

"*Second.* Suppose the truss-rods to be screwed up so as to give them a tension of 8 tons per square inch, or one-third their breaking tension; and, for the sake of simplicity, let us suppose that the half-length of the beam is 10 feet. This high tension of the truss-rods, it should be observed, will produce a dangerous action upon the cast metal.

"Suppose the beam to be loaded so as to produce a tensile strain of $7\frac{1}{2}$ tons per square inch upon the cast metal. Now, by Table IV., this would give an elongation of ·22 inches; but the truss had an elongation of ·077 inches due to the strain of 8 tons when the beam was in a neutral condition; therefore the total elongation of the truss-rod will be ·22 + ·077, or ·297 inches; but from Table II., we find this elongation to correspond to about 16 tons per square inch tensile force upon the rods. Thus, it appears, that even with the dangerous tension of 8 tons per square inch on the truss-rods, we cannot produce a higher strain than 16 tons upon them at the moment when the cast-iron is about to rupture.

"Reasoning in this manner, it may be shown, that it is impossible to construct a truss-beam which shall task the high tensile resistance of wrought-iron without at the same time introducing a dangerous action upon the cast metal. We have shown, in Tables II. and IV., that for high proportional tensions, the rate of elongation of wrought-iron is from 10 to 26 times that of cast-iron; hence it is impossible to have the two metals acting in concert at tensions approaching their rupture."

It is stated that the length of each of the truss-rods is here considered to be one-half the length of the beam, and the conclusions are apparently arrived at on the assumption that *the truss is extended as much as the under side of the beam.* But I fear that the extension of the truss cannot be so simply computed even approximately. Each truss is placed diagonally, and symmetrically situated with respect to the upper and the under surfaces of the beam; that is, there is as much of the truss above as below the centre of the depth of the beam. Therefore, if we regarded the compression of the upper surface alone, or the extension of the lower surface alone, the argument would be just as strong for concluding that the truss is *compressed* as much as the upper surface, as for concluding that it is *extended* as much as the lower surface.

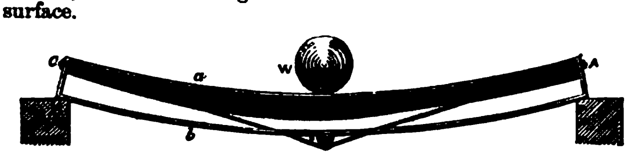



FIG. 2.

But, in truth, the effects at these two surfaces cannot be considered thus separately. The strain of the truss depends on the combined effects of the compression and extension at the two surfaces. *Four* causes may be here considered which materially affect the preceding computation of the strain of the truss. The *first* of these causes is the compression of the upper surfaces as just mentioned. The *second* of them is the deflection of the beam. If it be considered in its bent position as represented in the accompanying diagram, it is clear that on account of the curvature of the part $b$, the distance from B to C is less, *cæteris paribus*, than it would be if $b$ were straight.

The *third* of the causes in question is the varied tension of the underside of the beam. It appears to be assumed in the quotation that the under side of the beam is uniformly extended; but this is not so. This tension of the lower rib is greatest at its centre, and diminishes to nothing at its ends. Consequently, this flange is much less extended than is supposed in the preceding investigation.

There are three causes, then, either of which if it operated singly, would tend to make the tension of the truss even less than is here computed. Therefore, if these causes were not counteracted, not merely would the proposition of Mr. Fairbairn be established, but the insufficiency of strain of the truss would be even more than he has contended for. There is a *fourth* cause, however, which tends to counteract the three just mentioned; it is the inclination of the truss. This cause has more influence on the extension of the truss than any other.

The more inclined the truss is to the horizon the greater *cæteris paribus* is its extension produced by a given deflection of the beam. This may be shown as follows. In the diagram let BC represent the truss (of a given original length), in the one case little, in the other much inclined to the horizon. B and C are the two points of attachment to the beam, B being midway between the fulcra. AB is a vertical, and AC a horizontal, line. By deflection B and C will be both displaced. Let us suppose (as I shall presently show that we may) that the displacement of C is very small compared with that of B, and consider the only effect of deflection to be that of rendering B lower than it was before below $c$ by a distance B$b$. It is obvious that the more nearly the truss is horizontal, the less is the extension compared with B$b$. If the truss were originally actually horizontal, the extension would be ultimately nothing compared with B$b$; whereas if the truss were actually vertical, the extension would be equal to B$b$.

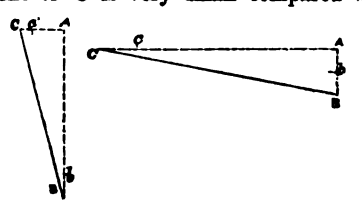


FIG. 3.

The inclination of the truss, then, is such a counteracting cause as has been above mentioned; if the effect of the horizontal displacement of C be small compared with that of the vertical displacement of B. That the former displacement is small will appear from this simple experiment. Holding a straight rod by one end, press the other horizontally against a wall. Then it will be found that a very small movement of the end held corresponds to a large deflection of the rod.

It would be extremely difficult to ascertain theoretically with exactness what the strain of the truss is, for the curvature of the truss does not follow the same laws as ordinary girders; the truss itself having a mechanical action which modifies the elastic curve. The following, however, is a method of approximating to the required result. Let A$c$ the original horizontal distance of the upper end of the truss to the left of the lower end $= a$; A$b$ the original vertical depth of the lower end of the truss below the upper end $= b$; the length of the truss $= l$; the increase of $a$ after deflection $= \text{C}c = h$; and the increase of $b$ after deflection $= b\text{B} = k$. Then $(bc)^2 = a^2 + b^2$; $(\text{BC})^2 = (a+h)^2 + (b+k)^2$.

$$\text{The extension} = \text{BC} - bc = \frac{ah}{l} + \frac{bk}{l},$$

neglecting powers of $h$ and $k$ higher than the first. But $h$, as has been shown, is usually very small. Therefore, when the truss is much inclined we may neglect the first term of the preceding expression. The extension therefore becomes simply equal to $\frac{bk}{l}$; or compute it by the rule of three, thus,

*length* of truss : *depth* of one end of it below the other
:: *deflection* of beam : *extension* of truss.

The inclination of the truss is not, however, generally so great that we can neglect the first term of the preceding expression

* "We have here considered the length of each truss-rod to be one-half the length of the beam. This supposition will obviously involve no appreciable amount of error."

When C is in the upper part of the beam, $h$ is negative, and the extension of the truss will be less than the foregoing computation by the rule of three would give it.

The conclusion that when the truss-rods have no strain on them originally, "the cast-iron would be ruptured by extension" before the truss-rods "could be strained to two-thirds their ultimate strength," is not supported by experiment. It appears from Mr. Fairbairn's first experiment (tabulated p. 47), that the girder "broke from one of the truss-rods yielding to tension;" but the extension must have been so small that this fracture was probably the result of accident.

Even though the truss-rod did not break simultaneously with the beam, it would by no means follow that the truss-rod was an improper or useless adjunct. It might still be the case that an increase of strength could be gained more economically by the proper use of the truss, than by adding to the mass of cast-iron —and this is, I think, shown by Mr. Fairbairn's experiments, noticed presently.

The real mechanical effect of the truss may be made most easily apparent by supposing its tension resolved into a horizontal and vertical component at one of its extremities. We may safely assume for the present that in the girder *not* trussed, the material is principally collected in the upper and lower flanges, and that the horizontal elastic forces of the part connecting them are small and nearly balance each other. Thus it is usual to consider that in a *simple* beam of the section $a'\ b'$, fig. 1, the total tension of the lower is equal to the total compressile force of the upper flange; the thickness of the intermediate vertical part being only just sufficient to develope the elastic forces of the flanges equally. But the tensile strength of cast-iron is so much less than its compressile strength, that the bottom flange $b'$ must be much larger than the top flange $a'$. If the bottom flange were of a material stronger to resist tension, its size in proportion to that of the top flange could be reduced. Now this reduction is precisely what is required by the introduction of the truss-rod. To understand its mechanical effect let us suppose its tension applied at B, fig. 1, to be resolved into a horizontal and a vertical component. Suppose, also, the beam divided in halves by a vertical section through B. What are now the horizontal external forces acting in that section upon the left-hand half ($BaCb$) of the beam? They are, a compressile force in $a$, a tensile force to the right in $b$, and the horizontal component of the tension of the *right-hand* truss (A B) acting to the right. This latter force concurs with and assists the tensile force of the lower flange to balance the compressile force of the upper flange. Therefore, as has been said, the lower flange needs not to be proportionally so strong as in the simple beam.

The same conclusion would be arrived at by considering the tension of the truss applied at C, to be resolved horizontally and vertically. The horizontal component acting along $a$ might be considered to be transferred to $c$, fig. 1, and there to oppose the compressile force, which therefore less tensile force of the lower flange would be required to balance.

Having now considered the horizontal effects of the tension of the truss, let us consider its vertical effects. I do not think their nature can be better designated than as *local disturbing forces*, which do not modify the relations among the forces external to the half-beam on which its equilibrium and strength depend. First these vertical components do not appear in the equations of equilibrium of the half-beam. To compute the strength of the right-hand half-beam B $a$ C $b$, fig. 1, we may take moments about a transverse horizontal axis through C. Then among the external forces must be reckoned the tension of the right-hand truss A B only. The horizontal component of this tension appears in the equation of equilibrium, but the vertical component passing through the supposed axis has no moment about it—that is, does not affect the strength of the beam. What is meant by characterising the vertical components of the tension of the truss-rods as "disturbing forces," is this: the ordinary theory of beams supposes the material composed of parallel layers, and regards only their longitudinal strains. Their strains in the direction of the depth of the beam are neglected, and for many purposes of approximation this simplification gives sufficiently correct results. But the vertical components of the tension of the truss-rod *may* add so much to the latter strains as to produce considerable strain of the beam vertically. In such case, the theory of parallel layers would no longer be even approximately correct. On the whole, it appears that the vertical part of the tension of the truss-rods is by no means advantageous. It seems therefore desirable to have those rods no more inclined to the vertical than is necessary; but it must not be forgotten that their obliquity tends, as has been explained, to subject them to the requisite strain by deflection. I concur therefore in the opinion of Mr. Fairbairn (p. 45), that it is inexpedient to unduly raise the points of attachment $a\ b$, but I have not been able to arrive at the conclusion stated by him, that the raising those points "increases the power of the truss-rods to rupture the upper flange of the beam." On the contrary, if I might venture to differ from so eminent an authority, I would submit that *cæteris paribus* the elevation of the points of attachment by increasing the inclination of the truss, diminishes the horizontal effect of its tension. That horizontal force, I have shown, is the only cause of an increased strain of the upper flange.

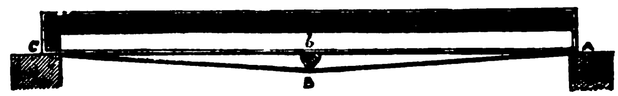




FIG. 4.

If the truss-rods were attached at the *under* side of the beam at A and C, fig. 4, the following result would follow. The points A C, being in the part of the beam which suffers *extension* by deflection, the requisite strain of the trusses would be greater by the displacement of A and B than if those points were in the part of the beam which suffers *compression*, because the strain of the trusses is diminished by the points of attachment to the beam approaching each other on its deflection. Their displacement is nearly horizontal. By varying the depth of $b$ B, the strain of the truss must be adjusted so as to insure its requisite tension. Probably for this purpose the inclination of the truss would have to be not very different from that in Mr. Fairbairn's experiments.

One most important point with respect to the use of truss-rods is, the form of section of the beams to which they are attached. A common, nearly universal, error is, to suppose that the form of section should be as in simple beams. But instead of the section being as at $a'\ b'$, fig. 1, with the largest flange downwards, it ought to be as at $d\ a'$, fig. 4, with the position of the section reversed, and the *largest flange uppermost*. The office of the tie-rods is to strengthen the lower side of a cast-iron beam, or to give it the strength which in a simple beam is obtained by an excess of material in the lower flange. The ratio of the areas $a'$ and $d$, fig. 4, would be difficult to compute, but the experiments show that in tie-rods of the strength usually employed, the area of $d$ ought to exceed that of $a'$. Indeed, this proportional excess may be increased *ad libitum* by increasing the strength of the truss-rods.

The following synopsis of the results of Mr. Fairbairn's experiments, which doubtless were carried out with the same skill with which they were evidently devised, fully establishes the foregoing conclusions. The following were the dimensions of the cast-iron beams of the sectional form $a'\ b'$, fig. 1, or $a'\ d$ fig. 4. The wrought-iron trusses, when used, were attached on both sides of the beam:—

| | |
|---|---|
| Length between the supports ... | 4 feet 6 inches. |
| Depth of beam ........................... | 4 inches. |
| Area of larger flange .................. | 1·05 square inch. |
| Area of smaller flange .................. | ·20 square inch. |

| Number of Experiment. | Section. | Breaking Weight in lbs. | Nature of Fracture. | Ultimate Deflection in Inches. |
|---|---|---|---|---|
| 1 | Small flange *downwards*, with truss of ½-inch diameter. | 5,502 | One truss broken by tension. | ·66 |
| 2 | Ditto, truss ¾-inch diameter. | 7,944 | Upper flange broken by compression. | ·988 |
| 3 | Ditto, ditto. | 8,854 | Ditto. | ·79 |
| 4 | Small flange *upwards*, *without* truss. | 5,830 | | 7·86 |
| 5 | Small flange *downwards*, *with* truss of ¾-inch diameter. | 12,316 | Lower flange broken by tension. | 1·06 |
| 6 | Small flange *downwards*, *without* truss. | 3,366 | | ·55 |

Let us first compare Experiments 4 and 5. In the former, we have the simple beam in its usual position; in the latter, the beam is reversed and trussed, and the strength is *more than doubled*. Mr. Fairbairn remarks, that the breaking weight in Experiment 5 would have been still greater if the upper flange had been of increased size. Comparing Experiments 1, 2, and 3, we observe, that where the truss is strong enough to resist fracture when the upper flange is broken by compression, there is a great gain of strength. Comparing 1, 2, 3, and 5, we find that the reversal of the position of the *trussed* beam greatly increased its strength. If we compare the ultimate deflections in Experiments 4 and 5, the advantage of the trussed beam properly placed appears still more strikingly, for it appears that its rigidity, measured by the ultimate deflection is between seven and eight times that of the common beam.

These experiments, then, seem to fairly lead to the conclusion, that most important advantages result from the use of the truss, and that the largest section of the beam ought to be uppermost.

Another striking view of strength of the trussed beams is, that they are much stronger than *wrought-iron tubular beams* containing the same quantity of material. In page 107 we have for the strength of the latter the following formula, which Mr. Fairbairn states that the experiments on them warrant—

$$W = \frac{60\,a\,d}{l},$$

where W is the breaking weight in tons, $a$ the area of the bottom flange, $d$ the depth of the beam, and $l$ the distance between the supports. To apply this formula to beams of similar dimension to those operated on in the preceding experiments, we must have $l = 54$ inches, $d = 4$ inches, and $a = 1{\cdot}05$ square inch, which is the dimension of the largest flange in the preceding experiments. It is to be observed, that in the tubular beams the area of the top flange is required to be much greater in proportion to that of the bottom flange than in the cast-iron beams; so that the quantity of metal required in the wrought-iron beams, in order to give the strength indicated by the formula, would be more than in these cast-iron beams. Applying the formula, however, we find $W = 60 \times 4 \times 1{\cdot}05 \div 54$ tons $= 4\frac{2}{3}$ tons $= 10{,}452$ lb.; whereas the strength of the trussed cast-iron beam, properly placed, was 12,316 lb. *Hence the cast-iron beam trussed appears stronger by more than* 15 *per cent. of its strength than the wrought-iron beam*; and this comparison is more favourable than it ought to be for the wrought-iron beam, for the material in it required for the computed strength has been under-estimated; and besides, the cast-iron beam appears, from Experiment 7, not to have been proportioned so as to have its maximum strength.

In an ensuing paper, I purpose to resume this subject, and to consider some of the properties of Trellis Girders, respecting which Mr. Fairbairn's experiments have elicited results as interesting and valuable as those above considered.

## THE COMMISSIONERS OF SEWERS AND THE GENERAL BOARD OF HEALTH.

Sir—Your readers are probably aware that the General Board of Health have succeeded in extending their usual system of obstruction to the operations of the Metropolitan Commission of Sewers. On the 27th February, the Commissioners received a communication from the Home Secretary, of which the following is a copy:—

"*Whitehall, February 18th.*

"Gentlemen—I am directed by Viscount Palmerston to transmit to you the inclosed copy of a letter from Mr. F. O. Ward, relative to the comparative advantages of the system of drainage adopted by the Commissioners of Sewers and the Board of Health, and I am to state, that in his Lordship's opinion, the system of drainage recommended by the Board of Health is that which ought to be adopted, as combining the greatest degree of efficiency with the greatest degree of economy.

"Henry Fitzroy."

This extraordinary missive left the Commissioners, as honourable men, no alternative but to resign their office as Commissioners, and not submit to have a most erroneous and most pernicious system of operation thrust down their throats by the indirect influence of a mere Pecksniff.

I have not been favoured with a copy of Mr. Ward's letter, which has so captivated the Home Secretary. There can be no doubt, however, but it has emanated from Mr. Chadwick, who is to all intents and purposes *the* Board of Health; aided, no doubt, by the more advanced of his apprentices, whom he now designates "Engineering Inspectors."

The Home Secretary must have relied principally upon his own engineering talents in arriving at the above conclusions; for without that make-weight there is only Mr. Chadwick, with some half-dozen apprentices in leading-strings, with the failure of his system at Croydon and several other places, to set against all the engineering talent of the kingdom, both civil and military, with numerous successful drainage operations on the most magnificent scale, as well as many minor successful works.

It may be laid down with something like axiomatic certainty, that there is no branch of engineering science which requires so much consideration as the efficient and permanent drainage of an extensive city—such, for example, as London; and it may also be asserted, that there is no branch of the profession in which the "hand-book system" ought more throughly to be deprecated than in the execution of extensive drainage works. Not only does every town differ from every other town with respect to drainage facilities, but every portion of a large town differs from every portion of the same town so essentially, as to make it absolutely necessary to consider and treat each portion on its own peculiar merits, and in reference to its own facilities.

There can never be a better criterion of quackery in any profession than that of propounding an universal mode of treatment for every possible variety of case, and under every variety of circumstance.

The Chadwickian system of *diminutive pipe-drains* meets every possible case of defective drainage under every variety of circumstance where drainage can be required, in the same manner and with as great success as Parr's Pills and Holloway's Ointment meet the varied cases of disease. Why not therefore dispense with the regular practitioners in both cases, and more especially in this age of boasted economy and unblushing effrontery?

The great peculiarity or leading principle of the Board of Health or Chadwickian system is, that the smaller the drain-pipe the more efficient the drainage. This leading feature of the system has been based upon erroneous formulæ, deduced from very limited and very imperfect experiments. These experiments were also, as a matter of course, made with pure water, but applied to sewage water of every possible degree of fluidity, and containing every variety of obstructing substance.

There are also very peculiar views held by the Board on the subjects of "combined back-drainage," "drainage-water supplies," "imperishable sewers," "distribution of sewer-water by pumping or otherwise, over adjacent lands," &c., and which views are repudiated by the most eminent and most practical men in the engineering profession.

It was certainly a bold stroke of Mr. Chadwick to attempt to foist his crude and ill-considered nostrum upon the Metropolitan Commission of Sewers; but having had such autocratic sway over the local boards in the provincial towns which have the misfortune to be placed under his sway, and being well aware that boldness and unscrupulous pretensions are essential to the success of an empereur—hence the *coup de main* upon the Commission.

It is scarcely possible to conceive of a case which more imperatively calls for a searching investigation by a select committee of the House of Commons than the entire working of the Health of Towns Act, and the manner in which it has been administered by the General and Local Boards, and it is to be hoped that some independent member will move for such a committee at an early period of the session.

C. E.

*** Subjoined is a copy of the letter from Mr. F. O. Ward to the Home Secretary, referred to by our correspondent, and made public subsequent to the receipt of his communication:

"17, *Stratford-place, Oxford-street, Feb.* 17*th.*

"My Lord,—The Commissioners of Sewers and the Board of Health are at issue as to the cheapest and best way of draining houses.

"The Board of Health advocate the drainage of each house block by tubular submain running behind the houses, and receiving the sewage of each by a short tubular branch. They recommend a large reduction of the sizes of drains hitherto employed for the single house drain; they recommend a 4-inch pipe for the submain receiving several of these; a 6, gradually expanding to 9·12, and so on up to 20, as the lengths of the submain and the number of branches received by it increase; such drains, they say, are self-scouring, the run of water through them is so concentrated that it keeps them clear of deposit; the branches being very short, and running backwards towards the drain behind, instead o forward beneath the houses towards a sewer in the street, have a quicker fall, and, in case of leakage, leak into the open air, not into the houses, while the cost is so much reduced by this method that blocks of labourers' houses may be thoroughly drained and fitted with sinks and soil-pans for an improvement-rate of less than 2*d*. per house per week.

"The Commissioners of Sewers, on the contrary, recommend large brick sewers under the street in front of the houses, beneath each of which they carry a long drain from back to front, strictly forbidding more than two houses being relieved by one pipe drain; a system which whether otherwise good or not, certainly entails an enormous increase of expense on the houseowners, and thereby redoubles the resistance on their part to sanitary improvement.

"The Commissioners of Sewers lay great stress on the independence secured by their system to each houseowner, whose premises are traversed by his own drain only, which he may take care of or neglect as he pleases, as its stoppage can only injure himself. They allege against the Board of Health plan, that it trespasses on private property, that any stoppage of the tubular submain exposes all the houses higher up to suffer, and renders it necessary for workmen to enter private back yards to search out and remedy the evil. They also deny the self-scouring property of the tubular submains, and refer in support of their view to several hundred cases of stoppages in tubular drains, collected in a report of Mr. Bazalgette.

"The Board of Health, on the other hand, declare the householders' pretended independence on this plan to be illusory, seeing that the big-street sewer is nine times in ten an elongated cesspool, where the sewage of each stagnates to the detriment of all, while the stoppage of a branch drain running beneath a house on the old plan often causes stench in the houses on either side. Against the inconvenience of an occasional invasion of the back-yards by workmen, they set the greater inconvenience of periodical invasions of the street and stoppage of the traffic, besides tearing up of kitchen floors to get at foul drains under the houses. In reply to Bazalgette's report, they bring forward examples by hundreds of pipe sewers working admirably year after year, and attribute such stoppages as have occurred to errors incidental to the first introduction of a new system—errors which, once known, may be avoided. Among these they cite the use at first starting of drain pipes which were too thin, so that they broke under the pressure of superincumbent earth, the uneven laying and careless jointing of pipes by the jobbing builders often employed (as in some parts of Croydon) on this work, the use of soil pans with ducts as large as the pipe drains to which they led, and, above all, the often scanty and intermittent supply of water to the system. They further point out that a population accustomed to open privies and cesspools, available as receptacles for solid refuse of every kind (refuse properly due to the ashpit), have to go through a transitional period of a few weeks, while they are learning that such practice leads to stoppage of the new circulating system, and must be abolished along with the old stagnant cesspols. They say that many of the tubular sewers put down as failures in Bazalgette's report, are at this moment working perfectly well, for which reason they take all his allegations with very great reserve. They point with some reason to Lambeth-square, New-cut, where the Commissioners have allowed 32 houses to be drained by four tubular dack drains, which act perfectly well, quite as well as 32 separate drains could act, though these would have cost eight times as much; and they ask, why this eightfold cost should be imposed upon London at large by the very same authority which sanctioned in this square the combined drainage, which is found to work well?

"The controversy is of immense importance, but I forbear further trespass to-day on your lordship's time."

"F. O. Ward."

## DRAINAGE AND WATER SUPPLY.*

In our numbers for February and March of last year, we published the cost of the private and public works of drainage and sewers in Rugby, Sandgate, Tottenham, St. Thomas's, Exeter, and Barnard Castle. We now give an abstract of the valuable report of Mr. Bazalgette to the Metropolitan Commissioners of Sewers, which from the great experience of that gentleman contains much that is of universal interest and conclusive upon many points connected with the theory and practice of effectual drainage and water supply.

Pursuant to instructions received from the Commission, Mr. Bazalgette proceeded to the five places named in our title, for the purpose of reporting upon the applicability of the systems of pipe drainage and water supply therein adopted, to the metropolis.

He states that the result of his inquiries and observations on the application of the tubular system of drainage in these five places affords no proof of its applicability to the metropolis, and no evidence of the cheapness and efficiency of the works at those five places, which should entitle the system to serious attention with reference to the works to be undertaken for drainage in London. In fact, the great difference of circumstances as affecting the drainage of a small country town and the metropolis, in respect of levels, weight of buildings, traffic and trade, quantities of drainage, and the distance it has to be conveyed, the cost of works, inconvenience of obstructions, depths of sewers, nature of soil, conditions of pavements, compensation for loss of trade, &c., payments to gas and water companies for protecting their mains, and various other sources of expense, scarcely leaves room for the comparison of the drainage and the cost of the two.

The conditions under which pipe sewers are and are not applicable, are—1. That, as a general rule, pipe sewers are not adapted to receive the surface drainage from those roads and streets upon which there is any considerable amount of traffic. If there be little or no traffic, there will be proportionately little refuse dropped upon them, and proportionately little detritus produced by wear and tear, to be washed by rains into the sewers; and if the surface be paved, there will be less road drift washed into the sewers than there would be from macadamised roads. 2. That pipe sewers are not fitted to receive both house and subsoil drainage. 3. That they require to have a considerable supply of water almost constantly passing through them. 4. That they require, under all circumstances, comparatively steep falls, and to be very carefully laid. 5. That they require to be sufficiently large to compensate for any slight settlement or irregularity in laying, and to admit of the passage of many of those innumerable substances which find their way into them, and which are now recorded "as having caused their obstruction and failure."

The places where all these requirements are obtainable, even in country towns and villages, are not very numerous; and the absence of some or all of them, in various instances, must considerably curtail the application, over any large area, of pipe sewers exclusively.

It is worthy of attention that a stoppage may exist in one part of a pipe whilst it is clear at a short distance further on; and that, in a porous soil, a stoppage in a pipe sewer may exist for a very long time without flooding the houses connected with the sewer, because the pressure of the sewage forces the clay out of the joints, which then become open, and the sewage oozes away through them into the soil. It is true that in such cases the houses escape being flooded, but it is only because the pipe sewer becomes a permeable elongated cesspool, attended with all the evils which have been so forcibly represented as attaching to the cesspool system.

In consideration of the number and variety of causes of stoppages in pipe sewers, a system so extremely liable to failure should be adopted with caution, and to a limited extent only. Thus, for instance, whilst an error in levels or a settlement in the ground to the extent of 3 inches would cause the choking up of half the area of a 6-inch pipe, it would only cause deposit to a quarter of the depth of a 12-inch pipe, and would be scarcely perceptible in the invert of a large brick sewer. Sewers are, moreover, required to carry off many solid substances, and if these are excluded by contracting the inlets to the drains, obstructions and floodings of the surface increase proportionately, and, to a similar extent, the sewers cease to remove the town refuse.

Economy has been urged in favour of the adoption of the tubular system in preference to the construction of large brick sewers. Upon this part of the question it is only necessary here to observe, that as an improved water supply is essential to keep a system of pipe sewers clear, the cost of the water supply must be considered in connection with that of the sewers; and, as pipe sewers do not provide for surface or subsoil drainage, together with house drainage, their cost must not be taken as the total cost of the entire drainage of a town. There must be added the cost both of constructing, and of maintaining, and repairing the surface and subsoil drains, without which the drainage of the town is manifestly incomplete.

### Rugby Drainage.

Rugby contains a population of about 8000, and about 1100 houses. The town rises with considerable inclination from the river Avon, which is the outfall for its drainage.

The town was originally provided with brick sewers, which are still in use, to carry off the surface and subsoil drainage; the house drainage having been generally conveyed into cesspools.

* 'Report upon the Drainage and Water Supply of Rugby, Sandgate, Tottenham, St. Thomas's, Exeter, and Barnard Castle.' By J. W. Bazalgette, Esq. Engineer to the Metropolitan Commission of Sewers. Published by Authority: 1854.

The completion of the public sewers may be considered, practically, the commencement of the drainage of the town.

The construction of private sewers and drains, and the laying on of water to the houses, are executed by the owners of the houses at their own cost, either voluntarily, or under compulsory powers enforced by the Local Board of Health as opportunity offers.

The private sewers and drains are composed of stoneware socket pipes, of London manufacture, the joints of which are formed in clay, it having been found that cement is liable to produce stoppages in the house drains by projecting and hardening inside the pipe.

The public sewers are laid at an average depth of about 8 feet. They vary from 6 to 22 inches in diameter. The private sewers and drains generally vary from 4 to 6 inches in diameter. The inclinations of the public sewers are upon the average remarkably favourable, being about 1 in 50 or 60. The best inclination is 1 in 19, and the worst 1 in 324. The inclinations for the private sewers and house drains are generally steeper, not less than 1 in 60.

The pipes have been laid down generally in the public thoroughfares; the road drainage is carried off mainly by the old brick sewers originally constructed in the town for that purpose. One of the branch sewers, which is laid at an inclination of 1 in 200, now receives as many as five gullies.

Wherever the road drainage is brought into sewers, it is certain that no description of gully or trap will suffice to prevent the road drift, whilst held in suspension in the water, from being carried into the sewer, afterwards accumulating in it, and ultimately becoming a source of inconvenience and expense.

The ventilation of the sewers has been effected where practicable by the connection of the rain-water pipes from the roofs with the sewers.

The water supply is obtained from the drainage of a gravel bed about a mile from the town. The present quantity supplied has, however, been found insufficient for the requirements of the town, and additional channels for collecting the water from a more extended area are about to be constructed. The water at present collected is conveyed by stoneware pipes, 7 inches in diameter, into a reservoir capable of containing about 200,000 gallons. An engine of 10-horse power is employed to raise it to a height of 110 feet, into an upper reservoir capable of holding 50,000 gallons; but a duplicate engine is still required, and will have to be provided to secure the certainty of the water supply at all times. The quantity of water now passed through the sewers is about 80,000 gallons per day.

The water is laid on upon the principle of constant supply; and the water pipes are laid at a depth of not less than 16 inches below the surface.

The cost of the water supply has been about 10,000*l*., exclusive of the extension now proposed, or the additional engine alluded to. That of the public sewers has been about 5000*l*. In these two sums are included the engineer's charges, 1090*l*., but they do not include the cost of the preliminary inquiry and report. The cost of the town survey, 814*l*., is not yet paid. The cost of the private works, including the laying on of water and destruction of the cesspools, has varied from 5*l*. to 50*l*. per house, according to the length of sewer and drain required to be constructed by the owner.

At an average of 8*l*. per house, the estimate would stand thus:

| | |
|---|---|
| Present water works | £10,000 |
| Public pipe sewers | 5000 |
| Private works | 8800 |
| Additional engine and extension of water works, say | 1200 |
| Total | £25,000 |

The cost of pumping is about 200*l*. per annum.

The cost of earthwork for laying the sewers, including the removal and relaying of the pavements, and all other incidental expenses, has been about 1*d*. per foot run for every foot in depth, or 10*d*. per foot lineal for a sewer laid 10 feet deep; which sum would not cover the cost of merely repairing the streets over such a work in London.

### Sandgate Drainage.

Sandgate is situated in a bay upon the sea coast, about a mile and a half west of Folkestone. It stands mainly upon a single line of road, running parallel with, and close to, the sea shore, at the foot of a range of hills, which rise precipitously from the sea, and prevent the extension of the houses excepting along the line of the shore. The beach, as well as the subsoil of the village, consists of shingle. The place contains at the present time about 330 houses, and a population of about 1400, which latter is considerably increased during the summer months by visitors for sea bathing, upon whom the village is mainly dependent for its support. From its position, resting upon a sea beach shingle, it required but little artificial drainage, all liquids percolating rapidly through the shingle into the sea. The present surface drainage has long existed in the shape of a few covered drains and open cuts, which admit of the rapid discharge of surface waters to the beach.

The private sewers and drains have been laid as much as possible in the public ways; and separate drainage for the houses has been adopted in preference to combined drainage, because it was found to be very difficult to get the owners of property to agree to carry out the latter, and the system of draining the houses separately was in general more satisfactory in the result. The sizes of the public sewers vary from 6 to 12 inches diameter, and their inclinations from 1 in 6 to 1 in 320. The surface drainage of the roads has not been admitted into the pipe sewers. The rain water from the roofs of houses is generally admitted as tending to cleanse the pipes. The pipes are of stoneware with sockets, from London, the joints of which are made of clay. The depth of the sewers averages from 5 to 6 feet below the surface. The public sewers consist chiefly of four lengths of pipes, forming one line, laid under the north side of the main street. These lengths severally are of 6 inches diameter at the upper end, and increase to 9 inches. They are arranged in two pairs; the lengths of each pair fall from opposite directions and meet at a certain point, whence they discharge through a common outlet, at right angles with them, into the sea. These lengths measure, respectively, 583, 320, 203, and 330 yards. The first portion of the outlet for the first two lengths is a 12-inch stoneware pipe, 73 yards in length: total, 1509 yards of stoneware pipe. The first two lengths discharge through a 12-inch pipe into a large egg-shaped brick reservoir sewer 7 ft. 6 in. by 5 feet, and 60 feet long. The reservoir sewer is below high-water, and stores the sewage for about three hours per day. It is furnished with a flap and iron discharge pipe to low-water. The other two lengths of main line discharge into a separate iron pipe laid at right angles to them, and across the beach to low-water.

The remainder of the public sewers consist of short branches falling with good inclinations into the above four lengths of main line. The general inclination of the main line varies from 1 in 240 to 1 in 320, with the exception of about 253 yards at the eastern end of the eastern length, the inclination of which varies from 1 in 15 to 1 in 25, and of about 118 yards more at an inclination of 1 in 120.

As a proof of the unsuccessful working of pipe sewers, after deducting 253 yards of the pipes, which have a fall of from 1 in 15 to 1 in 25, it appears, that out of the remaining aggregate lengths of main line, amounting to 1256 yards, 816 yards, or about two-thirds of the whole length, have already once failed and been relaid.

When 9-inch pipe sewers are laid, excepting in short lengths and with steep falls, so nice an amount of accuracy in the levels and workmanship is essential to secure efficiency, as to be scarcely attainable in practice; but even if this theoretic perfection should, in the first instance, be attained, the work is liable, afterwards, to be deranged by partial settlements and other unavoidable causes, any one of which is sufficient to produce the failure and inconvenience experienced at Sandgate.

The water supply is obtained by laying rubble stone collecting drains into the sand bed in the range of hills forming the northern boundary of the village, and thus collecting the drainage into two covered reservoirs. The western one is elevated 83 feet above Ordnance datum, and the eastern one 67 feet. Each of these reservoirs is capable of containing about 20,000 gallons.

The supply of water is upon what is termed the "constant supply" system; but there has been so much waste from leaving the taps open, that the surveyor has been obliged to turn off the water from the mains every night for some months past, to give a sufficient supply during the day time, so that, during the night, the houses, having no cisterns, are left entirely without water, instead of having a "constant supply." The drain pipes are laid upon one side of the main road, and the water-supply pipes on the other.

The average cost of the private works has been from 7*l*. to 8*l*.

per house; but, in some few instances, the cost of the drainage alone amounted to seven guineas per house. Taking the average at 7*l.* 10*s.* per house, these works when completed, will amount to 2475*l.* The public works cost,

| | |
|---|---|
| For water supply, about | £2266 |
| And for drainage works | 1000 |
| Total | £3266 |

This sum does not include the cost of the preliminary inquiry (170*l.*), nor the cost of the town survey, which has not yet been charged. But it includes the sum of 213*l.* paid for the previously existing water-supply pipes which are now used, and 100*l.* premium to the owner of the former water supply, and the engineer's charge of 314*l*, the clerk of works' charge of 90*l.*, and the legal expenses. So that the actual cost of these works to the place will amount to somewhat about 6000*l.*, including the survey and preliminary inquiry, but not including the surface or subsoil drainage. The estimate, therefore, will stand thus:—

| | |
|---|---|
| Water supply | £2226 |
| Public sewers | 1000 |
| Private works | 2475 |
| Preliminary inquiry | 170 |
| Survey, say | 89 |
| Total | £6000 |

The contractors' bill for relaying the pipes last year amounted to 77*l.* 13*s.*, being only about 7½*d.* per foot lineal of sewer relaid.

We shall complete the notice of this Report in our next number.

## HYDRAULIC PRESS.

— Dudgeon, *Patentee*, 1852.*

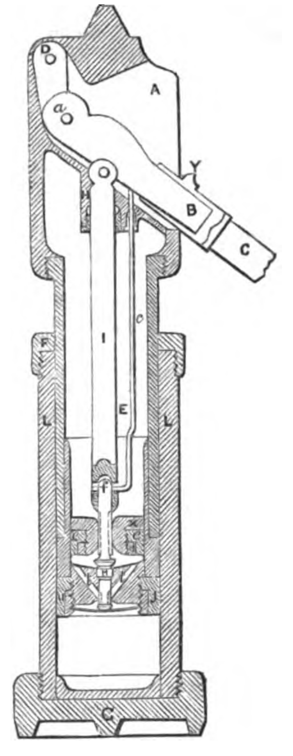
This ingenious and useful apparatus is becoming extensively introduced as a substitute for the old jack-screw. The advantages it possesses are, 1st, Its lightness, which makes it easy for one man to shoulder a press capable of raising ten tons. 2nd, The small power required to work it, every press being arranged so that one man can raise the weight for which the press is calculated. This advantage must be obvious, when we reflect that the friction of the old jack-screw, which is enormous, particularly when the oil has been gummed by cold or dirt, is replaced by the very trifling friction incident to the passage of the fluid in the press through the openings. 3rd, The ease with which heavy bodies may be lowered, which may be effected slowly or rapidly, as desired, by simply touching the relief valve with the working lever. 4th, The convenience of using it in confined situations, where it is difficult or impossible to turn the lever of the screw. To those who are accustomed to the use of the jack-screw, and who are therefore acquainted with its inconveniences, the advantages of this press will be evident.

The inventor has proposed to apply the same arrangement to pressing cotton and goods; and indeed he exhibited in the Crystal Palace, New York, a small press of the kind, which appeared to be very convenient, and certainly cheaper than any other form of press with which we are acquainted.

The press, or "jack," shown in the engraving presents a cylindrical appearance; it consists of an outer cylinder, or case, resting on the ground, and an inner cylinder, or ram, surmounted by a boss, in which the working lever is pivoted, and which is placed under the object to be lifted, of course moving up with it. The peculiarity of the arrangement is, that the *pump* is within the hydraulic press. The liquid used is oil, of good quality, which, however, ought occasionally to be renewed; and the ram is made hollow, in order to form a reservoir large enough to contain the oil when the jack is down.

The size of the cylinder (inside) varies from two to eight or more inches, according to the weight for which the press is designed; one of 3½ inches will readily lift 10 tons, and can be worked by one man with greater facility than two men could raise the same weight by a jack-screw.

The ram, with its head, contains just so much oil or other fluid as is requisite to fill the cylinder when the ram is all the way up; and when it is lowered, the fluid returns again to the original cavity upon the small valve *h*, being forced open by the lever. This lever is detached, and may be put in at pleasure; it is shown in the engraving upside down, and the press is in the act of lowering, so that the lever, by being pressed down, has forced open the small valve *h*, by the rod *e*, acting on the piston *f*. When the lever is raised, a small spring under the valve *h*, shuts



it, and arrests the descent of the ram. When the ram is to be raised, the lever is taken off, and put in right side up, or with the projection *y*, downwards; which brings up on the bottom of the slot in which the lever works, and limits its down stroke before it touches the rod *e*. The force pump barrel J, is fitted into the lower end of the ram, and its piston, consisting of top and bottom pieces *x* and *d*, with leather between, is connected by the rod I, to the lever B. The valves *f*, and *h*, have gutters or channels cut in their sides, along which the fluid can pass when the valves are down or open; the piston rod I, is kept in line by passing through the stuffing box H; and the short link D, to which the lever is attached, makes a species of parallel motion. The piston and ram and the cylinder bottom are kept tight by cup leathers, as used in hydraulic presses. The action of the pump will be readily seen by reference to the cut. When the ram and piston are both down, both valves are seated. On moving the piston up, the liquid above presses open the valve *f*, and flows into the cavity under the piston as it ascends. When the lever is again moved down, this same liquid shuts the valve *f*, and opens *h*, flowing beneath the ram, and raising it. This jack may be used either vertically or at any angle with the horizontal line. The head must, however, be slightly raised, to induce the fluid to pass the valves.

## DWELLING-HOUSE IN COBOURG.

(*With an Engraving, Plate* XVI.)

This house is intended for the occupation of a person engaged in business, and his family, and is arranged with all necessary conveniences. The arrangements for lighting are so managed as to give sufficient light in the interior of the building, where most of the living rooms and domestic offices are situated, and which are so managed that they can be made to communicate with each as the occupants may desire. The entrance to the cellars is under the main staircase.

The exterior of the building is made to break the lines of the masonry and windows by means of a tower which gives access to the garden, and likewise gives it the character of a villa residence. The decorations are of a modern character and of various styles, the blending of which, it is considered by the architect, is the proper mode of following the tendencies of the present day towards the creation of a new style, and calculated to produce a pleasing effect.

The masonry of the exterior walls is in rubble, with sandstone dressings. Brick courses are introduced for variety. The tower and windows are dressed with sandstone, and the window sills are of burnt clay. The roof is of brick.

The cost of the building was 13,000 thalers, or 2160*l.* It is erected from the designs of Hofbaumeister Scherzer.

* From the 'Journal of the Franklin Institute.'

ELEVATION OF GARDEN FRONT OF DWELLING HOUSE AT COBURG.


J. R. Jobbins.

## ON THE FRENCH AND OTHER METHODS OF CONSTRUCTING IRON FLOORS.

The discussion on the above subject, which had already occupied the attention of the three previous meetings of the Royal Institute of British Architects (see *Journal, ante* pp. 54, 90), was resumed on February 20th by Mr. C. C. Nelson, Hon. Sec., reading the following communication from Mr. H. J. Stevens, of Derby:—

"I beg to offer the following information as to the nature of the floors to which Mr. Garling alluded during the discussion at the Institute on the 6th February. Gypsum or plaster, from the quarries near Derby and parts of Nottinghamshire, is very extensively used for chamber flooring in this district, and its durability, when properly prepared and laid down, fully equals what Mr. Garling asserted. The coarsest description of gypsum is used, and after calcination is broken down with wooden flails. It is kept in a dry state, and when laid is mixed with water to the consistence of rough mortar, and spread over the wood joists on reeds or laths to a uniform thickness of 2 inches to 2½ inches. It hardens very rapidly, and the workmen use a long float of wood for levelling it, and on the second or third day it is polished off with boulder stones or trowels. It is desirable that the surface should not be broken by using the floors too soon after they are laid; it is also usual to give an increased hardness by a coat of linseed oil, and in Nottinghamshire the floors are painted, and look extremely well. Two sides of the room have wood fillets laid down, varying in thickness with the superficies of the floor, which being removed immediately after it is laid, allow for the expansion, which is not only very considerable, but continues for some time. Floors of this material are very strong, and are extremely well suited for cottages, being in this district much cheaper than inch white deal—*2s. 3d.* to *2s. 9d.* per superficial yard is the builder's price for laying them down, including reeds, laths for securing the reeds, and plaster. The under surfaces of the joists are edged, and sometimes planed, and the ceiling is formed by the plastering of the reeds between the floor timbers, for which an extra *3d.* per yard is sufficient. These floors are to a certain extent fireproof, and having a smooth surface are easily cleaned, and afford no harbour for vermin; on these accounts, as well as for their cheapness and durability, plaster floors, as they are called, are almost invariably adopted in the Midland Counties, where the carriage of the material does not operate as an objection. Mr. Garling is wrong as to the *finer quality* being laid over the coarser material. I believe what is herein stated will give you the detail of the process, and I have only further to observe, that it admits of being burnt over again, and it is considered desirable that a certain proportion of old plaster should be mixed with the new; when that is the case the floors are found to set harder. I have seen this coarse flooring plaster used externally as pane work in half-timbered construction, and believe it to have been two or three hundred years since it was worked into the building. I offer these observations for the information of the members of the Institute, as there does not appear to be a clear notion of the uses to which the gypsum of this neighbourhood has been applied for many centuries. It is not improbable that the material may be adopted for flooring in connection with a system of fireproof construction, and it might be desirable for some of our scientific members to examine and analyse its composition. I am disposed to disagree with Mr. Christopher as to the extra expense necessarily incurred by the adoption of Fox and Barrett's system of fireproof construction, but I have no doubt that Mr. Barrett will easily bring proofs that neither extra foundations nor hoop-iron bond are required; that the hoisting, &c. are included in his statement of *cost*, and that wood filleting for carpets cannot be necessary where a boarded surface is added."

Mr. T. H. Wyatt having before expressed a strong opinion in favour of Messrs. Fox and Barrett's system, was anxious that it should not be supposed that he had adopted it without mature consideration. He had heard with much surprise and pain the strong remarks of Mr. Christopher objecting to this system, for he could not but remember that his own attention had been first directed to the patent by a pamphlet of Mr. Christopher's published in 1848, which eulogised the system in a manner, compared with which, any praise which he (Mr. Wyatt) had given to it was as cold as possible. Certainly, his own experience, together with that of his friends, Mr. Salvin, Mr. Clarke, Mr. Rhode Hawkins, and others, who had used it largely, justified the opinions he had already expressed. He himself had never used it for roofs, neither had he used cement floors; and he was strongly of opinion that the failures which Mr. Christopher referred to had arisen from an injudicious application of the system rather than from any inherent defect. A principal objection raised by Mr. Christopher was the want of a good key for the ceilings; but having used the system successfully in four or five large buildings, especially in the Wiltshire Lunatic Asylum, where, from the constant vibration in the refractory cells and in the corridors, the ceilings were subjected to the severest test, he felt convinced that any failure elsewhere must have proceeded from bad workmanship, and in this opinion he was confirmed by the friends already mentioned. With respect to the time necessary for the drying of the concrete, he thought it rather desirable than otherwise that a check should be given to the rapidity with which buildings are now carried up; and in his own practice he had not found the difficulty to exist with a proper supply of air and provision of fireplaces, which did not exist in one of the buildings erected by Mr. Christopher. Mr. Christopher, in his pamphlet, had thus described the excellence of the ceilings at "Northwoods":—"The ceilings are finished, and appear as usual, but equalling the best, as they remain for fifteen years without a crack!" Mr. Christopher had objected to the solidity of the patent floors, as interfering with the supply of air to the fireplaces. He (Mr. Wyatt) thought it was much better to depend upon an artificial supply of air than upon that which came through the interstices of the floor bringing dust with it; and the objection, if any, applied equally to a good wooden floor, properly tongued and pugged. On the question of cost, Mr. Christopher had now given an opinion directly at variance with that expressed in his pamphlet, in pages 3 and 7 of which he stated that "Buildings may now be constructed fireproof without increasing the cost of erection; the above *grand desideratum* in the art of building is now no longer *theoretical*, but a fact supported by just such testimony as could be desired—viz., the existence of a building on a large scale erected throughout in the manner referred to, *which has not cost more* than if it had been constructed in the ordinary way. The roofs—at from one-half to one-third the cost of the usual roof.—*Economical*, rather less costly in first construction, and *much* less in use, from being *indestructible*." As he (Mr. Wyatt) had before mentioned, the adoption of Fox and Barrett's system in the Wilts Lunatic Asylum had not involved the expenditure of an additional shilling beyond the original estimates. He certainly could not suppose that any extra strength in the foundations was necessary in this system. The only difference in the weight sustained by them, as compared with a case where ordinary floors were used, would amount to four hundred weight on the square foot in a building of five stories; and no prudent architect would make foundations so weak that they could not sustain so small an extra weight as this, a tithe of the crushing weight. In his pamphlet, Mr. Christopher had expressed a very different opinion, and stated, that "the requisite strength is fully developed by combination and perfect union, giving equally sustained solidity to every part, while from the lightness of the floors and roofs, and their being quite level (without lateral thrusts), the inclosing walls need not be thicker than usual." For the same reason, he (Mr. Wyatt) did not conceive the use of an extra quantity of hoop-iron bonding at all necessary. In the case of the Thames Chambers referred to by Mr. Christopher, the nature of the locality might have suggested this precaution, which under ordinary circumstances was unnecessary. The objection raised as to the expense of cutting and trimming joists to suit openings and chimney-breasts, bore rather hardly upon the system, especially as the patentees took great pains to prepare their joists and girders accurately. Generally, Mr. Christopher had been very severe upon the estimates of Mr. Barrett. He (Mr. Wyatt) had not gone minutely into those estimates, but he had sent them to a surveyor in whom he could place confidence, who stated that they were perfectly honest, and applicable to the present time. It was not fair to compare this system with a wooden floor, as it should rather be compared with the French or some other kind of fireproof flooring, and if that were done, he believed the result would be in its favour. After a long discussion on the subject, the Institution of Civil Engineers had approved of the plan, the Inspectors of Prisons and the Official Referees had also treated it as a satisfactory and efficient fireproof construction; and he had himself found it to answer all his expectations. Whether this system or the French system should be considered preferable, one important point suggested itself in the present discussion, namely, that a very heavy responsibility would rest upon them and their successors as architects, if they should disregard the fact that there were systems known by which essentially fireproof construction could be attained with very little extra expense; and it was their duty therefore to test these systems as severely as possible, and to employ one of them whenever they had the opportunity of doing so. Some of the rooms in the Wiltshire Lunatic Asylum were 16 feet and 18 feet by 24 feet; the corridors being 150 feet by 12 feet. The rigidity of the floors was remarkable, and the only doubt which ever arose in his mind had been caused by the appearance of a dark line on the ceiling immediately under each joist. This he had thought proceeded from some chemical action, but it had been entirely removed by the second coat of lime whiting.

Mr. Papworth referred to the letter of Mr. Stevens of Derby, and inquired what amount of space in proportion to the whole superficies should be left around a plaster surface to allow of its expansion. His own experience suggested that 1½ inch on every side of a floor for every 10 superficial feet would not be too much.

Mr. Wyatt concurred in this opinion, and referred to a loft at the seat of Lord Cardigan in Northamptonshire, where the walls had bulged from the expansion of a plaster floor, although a space had been left originally to provide for this occurrence.

Mr. Inman (the Chairman) stated that floors of plaster, sometimes mixed with coal ashes, were in general use in large mansions in the vicinity of London about eighty or a hundred years ago. This was the case in some of the upper floors at Hampton Court Palace, where a layer of cockle-shells about 2 inches in thickness was also introduced in the floors, for the purpose of deadening sound.

Mr. Boulnois observed, that in his experience of Fox and Barrett's system he had never found the ceilings give way, though he had employed plaster of Paris to gauge them. From his remarks at a former meeting, it might have been supposed that he disapproved of this system, but on the contrary, he thought it an admirable system, and by far the best mode of fireproofing ever introduced. One great advantage which it possessed was that of economising height, which was a point of the greatest importance in London. With respect to Mr. Christopher's opinions as expressed in his pamphlet, and those which he had now put forth, it should be remembered that that gentleman had in the first instance been led to publish his opinions without having had any actual practical experience of the system. This experience he had since had, and, as the meeting knew, it had proved unfortunate to him, inasmuch as he had been subjected to an action at law and other difficulties. He (Mr. Boulnois) therefore contended, that it was the duty of the patentees to ascertain and remove all such difficulties and defects as Mr. Christopher had met with in his practice, and not to allow the task to devolve on the architect employing their system of flooring.

Mr. H. H. Burnell contended that the French system presented greater economy of space than the English, and that the latter was very defective in respect to its giving no key for the ceiling.

Mr. Wyatt said he had no doubt that Mr. Christopher had written his pamphlet, 'Notes of a Visit to Northwoods,' with the most perfect conscientiousness, but after expressing himself so very strongly in favour of the system there used, and leading others to adopt it, he of all persons should have dealt as leniently as possible with any defects to which it might be liable. For himself he had found that the system fully justified the praise which Mr. Christopher *originally* bestowed upon it.

Mr. Christopher reminded the members that at the commencement of his former remarks he had stated that he thought very highly of Messrs. Fox and Barrett's system. He had made minute inquiries of Dr. Fox, of his architect, and of the workmen at Northwoods, and was led to express his opinion very strongly in the pamphlet quoted by Mr. Wyatt; and he still thought that for all practical purposes this system, from its economy, was superior to any other for fireproof construction. He was therefore gratified to find, that Mr. Wyatt, after his extensive experience, did not think the warm approval which he (Mr. Christopher) had formerly expressed in any respect overcharged. On reading the remarks which he had made at the last meeting, he confessed they appeared rather strong, and he should be sorry if they were to injure the patentee. Still, however, after four or five years' experience, he had found imperfections in the system which had occasioned him much annoyance and loss, and he felt bound to caution his professional brethren on the subject. These, it was true, were comparatively *little* defects, and he did not wish to magnify them. He was not desirous to retract any of his former remarks, as he believed them to be strictly correct, with the exception of an obvious error of 1*l.* for fillets to a boarded floor in the estimate for a room 20 × 20 feet. Mr. Beck, in reply to an appeal from Mr. Barrett, had stated that he did not think it necessary to make any addition to "the footings of the walls" for this system; but what he (Mr. Christopher) considered necessary was to increase the "foundations," a distinction recognised in the Building Act and by other authorities. It was essential to be very careful with the foundations where this system was employed, especially if a rigid material like Portland cement were to be used for the floors. Hoop-iron bonding he considered necessary, as in the patent system there was no provision for a tie, and no substitute for the timber plates used in ordinary construction. Again, the play of the iron joists before the concrete was filled in was objectionable, and liable to loosen the green brickwork; and it had obliged him to take out the arches over openings and substitute stout iron lintels. He had not ventured to offer the remarks he had made in any case from the result of *one or two failures only*, and in all cases first-rate builders had been employed by him, and no expense or pains had been spared. On the subject of cost he had confined himself to *Mr. Barrett's estimates*, published in the Transactions, and the question was, are those correct, and not what the Wilts Asylum may have cost some years ago, when iron was at less than half its present price. With reference to the question of cost generally, he (Mr. Christopher) should not have entered upon the subject if Mr. Barrett had not endeavoured to show that his fireproof floors could *now* be constructed cheaper than ordinary floors of the best kind. Mr. Barrett had made a deduction of *one-half* the cost of the iron from his estimate for "excess of strength," and this deduction was one which he (Mr. Christopher) thought quite unwarranted, because if the strength of the floors were proportionably diminished they would not be safe.

Mr. Wyatt stated, that what Mr. Barrett said was, that he would not like to take the responsibility of the lightness of the French mode of construction, but that a great reduction in his standard of strength might safely be made.

Mr. Christopher repeated that Mr. Barrett's estimates were incorrect; that when he went into the matter with that gentleman they found it impossible to reduce the price to that of an ordinary timber floor, and that the additions made by him to Mr. Barrett's estimate for cutting and trimming joists, the use of the license, &c., were fair and moderate additions. Carefully detailed accounts had been kept of the recent buildings erected under his direction to test the result, and from these he had quoted, but Mr. Wyatt admitted he had not gone into the estimates. Another point that deserved consideration was, that many persons would desire a wooden floor upon the concrete foundation; in that case a considerable extra cost was incurred, and some of the advantages were lost, as the building was less fireproof, the floor afforded a harbour for vermin, and was liable to rot, besides which there was a loss of space. With respect to the roofing, it should be observed, that at Northwoods the concrete roofs were all finished with tarred paper and sand, which had been found successful. The Building Act however precluded the use of these materials in London, and therefore cement *alone* was used, which had failed, as before described. Now, although this question had been discussed chiefly with reference to *floors*, it appeared to him that the *roof* was the most important consideration with respect to fireproofing, as many buildings had been ignited through the roof from fires in adjacent buildings, and certainly if *floors* could be constructed on this principle at the same cost as ordinary floors, *roofs* could be constructed at less than half the ordinary cost.

Mr. Barrett wished first to offer a few remarks in reference to some observations made by Mr. Tite at a former meeting. That gentleman stated that the system of fireproof construction which Mr. Barrett had explained was very similar to one which he (Mr. Tite) had himself used twenty-eight years ago. There were however important differences both in the principle and the cost. In the plan referred to by Mr. Tite the stone landings were merely a modification of the iron girder and brick arch system; they were a dead weight upon the girders, and not an element of strength; while in his own plan the union and combination of the different materials produced a great increase of strength and rigidity, and at a small expense. In the one case these important qualities were derived from the *iron*—a costly material; and in the other from the *concrete*, a very inexpensive one. But the real question was, not whether any of these materials had been previously used in the construction of floors, it was rather whether they had been so arranged and combined as to produce a satisfactory floor of incombustible materials at a cost little, if at all exceeding, that of the ordinary timber construction; whether, in fact, it could be said before the introduction of this system (as it had been said by Mr. Wyatt) that a large and important public building had been constructed on a fireproof principle without incurring one shilling additional expense. Reckoning the cost of the 4-inch and 6-inch self-faced stone landings at prices furnished to him by a contractor, viz., 1*s*. 6*d*. and 2*s*. per foot, and assuming the iron to be no heavier than in his own case, the actual cost would be more than double that of his construction; thus—

*Dimensions of Room*, 12 × 12 *feet*.

| | | | |
|---|---|---|---|
| 144 ft.—4-in. landing—at 1*s*. 6*d*. | £10 | 16 | 0 |
| Iron work, as at page 92 | 3 | 15 | 8 |
| Facing surface and forming cement ceiling, 6*d*. ℔ ft. | 3 | 12 | 0 |
| Total | £18 | 3 | 8 |
| Instead of | 7 | 14 | 10 |
| Difference | £10 | 8 | 10 |

*Dimensions of Room*, 20 × 20 *feet*.

| | | | |
|---|---|---|---|
| 400 ft.—6-in. landing—at 2*s*. | £40 | 0 | 0 |
| Iron work, as at page 92 | 21 | 4 | 3 |
| Facing surface, &c. 6*d*. ℔ ft. | 10 | 0 | 0 |
| Total | £71 | 4 | 3 |
| Instead of | 32 | 4 | 3 |
| Difference | £39 | 0 | 0 |

He thought therefore there was sufficient reason for such a system never having come into general use. Mr. Tite had also referred to the decoration of ceilings, but he could not imagine any difficulty whatever to exist on this head, and if none was found in erecting a residence for the highest personage in the realm, there was little probability of its occurring elsewhere. Certainly, any kind of decoration that could be combined with the girder and arch system could, with at least equal facility, be applied to his construction: but upon this point any member present might satisfy himself by inspecting the new offices and station of the Brighton Railway Company at London-bridge, where the system was carried out on a very extensive scale, some of the bearings exceeding 35 feet, and where many of the ceilings were of a highly decorated character. Mr. Tite had also spoken of the possibility of the concrete yielding under the action of fire if it were formed with flints. This material was however never used for the purpose; the concrete being made of fine gravel or ballast, broken brick or tile, burnt earth, and lime. Upon this point he thought an important consideration had been overlooked, viz., the fact that in warehouses where large fires occurred, they were mainly owing to the circumstance that the timber floors themselves afforded both the fuel and ready supply of air to support and extend the fire, which would burn but slowly till it had consumed a portion of the floor, so as to obtain a supply of air. The case however was very different, if instead of a floor being of a highly inflammable nature, it was formed of a solid mass of incombustible materials 12 inches thick, by which the supply both of fuel and of air would be cut off. The fire, generating an atmosphere which will not support combustion, would under such circumstances probably burn itself out. Even supposing any intense degree of heat to be generated, before it could act injuriously on concrete it was probable that it would quite destroy a brick arch, either by disintegration or by the expansion of the arch, and the consequences which might result from the failure of a single arch in a building were fearfully exemplified in the fall of a cotton mill at Oldham some years ago, the replacing of one of the arches which had settled having led to the breaking of the iron beams from the lateral thrust of the adjoining arches, and the sudden and instantaneous destruction of the entire building—a calamity which could never possibly happen with his plan of construction. With regard to the objections raised by Mr. Christopher at the last meeting, there could be no question that Portland cement should never have been applied as a finished covering for roofs, but that gentleman had not stated that he had himself preferred it and introduced it. Indeed, he was the first to erect a roof upon the principle since the completion of the original building, the roofs of which he, "after careful inspection," greatly admired, and described in 1848 as being "marvellously simple and inexpensive while efficacious, being perfectly waterproof, and much more impervious to the variations of temperature than the usual roofs,—those built eight years since being perfect, and the ceilings under them without a stain." Mr. Christopher had adhered strictly to the construction of these roofs, except in that part which in his case had failed, viz., the finished covering, which he had formed of Portland cement instead of tarred paper and sand, the use of which was said to be prohibited by the Metropolitan Buildings Act. It had been intimated by that gentleman that the failure of the cement covering might have been occasioned by the expansion of the concrete; but the fact of its remaining sound for twelve months shows that it could not have arisen from that cause. Concrete does unquestionably expand *in setting*, but not afterwards. Mr. Christopher had moreover told him that the experience of a brother architect showed that when Portland cement was laid on brick arches there was the same uncertainty as to the result. It was however admitted, that metallic lava answered, and he might add, that asphalte, tiles in cement, and slates in cement, had also been applied with perfect success. As a finished surface for floors, Portland cement had answered perfectly in several instances, but it was a very uncertain material, and in those cases where the floors were not to be carpeted or covered, or where a slight superficial defect was of consequence, it would be better to use a cement of another description, such as Keene's, which had been substituted for Portland in a large building lately erected by Mr. Clarke—the Metropolitan Convalescent Asylum—at an additional cost of only 30*l*., and it certainly looked much better. With reference to the ceilings, and the alleged want of a good key having occasioned several falls, Mr. Barrett first observed, that if this really were a radical defect in the system, it admitted of a very simple remedy, for nothing could be easier than to attach the ordinary lath and plaster ceiling by means of light fillets placed parallel with the joists. So far however from the key being defective, he had been assured by practical men, plasterers, and foremen, that the key was a much better one than in the ordinary construction from the greater strength of the laths. He had communicated with several members of the profession who had used the system largely, upon this and other objections stated by Mr. Christopher; amongst them were Mr. Wyatt, who had had from 1400 to 1500 squares of flooring constructed; Mr. Rhode Hawkins, 530 squares; Mr. Brandon, 900 squares; Mr. Clarke, 400 squares; Mr. Salvin, 500 squares; Mr. Holland, 1200 squares; and Mr. Piper, 1400 squares;—in the aggregate several thousand squares; and it was remarkable, that out of so large a quantity no instance should have occurred of a ceiling falling. In Mr. Christopher's case, he believed it to have arisen from his having kept coke fires in the middle of the room, *upon the concrete, for several weeks in succession*, to dry the plastering of the walls, as the portion of ceiling which fell was directly under one of these fires.—The Report of a Committee of Magistrates who visited Northwoods to see the original building was to this effect: "Our attention was first directed to the very beautiful and perfect appearance of the ceilings of the rooms (after fourteen years duration), which are in fact a part of the fireproof floor; these ceilings, even after so long a period, presented a perfectly plane and level surface, and were quite free from cracks;" and Mr. Christopher's own report of this building was, "the ceilings are finished, and appear as usual, but equalling the best, as they remain for fifteen years without a crack!" Mr. Christopher had also stated, in reference to the ceilings of the building, the roof covering of which had failed, "the ceilings were everywhere entirely free from cracks, and decidedly more perfect than in ordinary buildings." In conclusion, Mr. Barrett begged permission to read the following letters from some of the gentlemen he had referred to.

1. *A communication from* Mr. JOSEPH CLARKE:

"I feel I ought to add my testimony to what I consider the full success of your patent, which I have adopted in several important buildings for some years past. I must say that I have not met with a single failure, and certainly on the points of objection which I hear have been raised:—1st. That the adoption of the system involves greater expense in foundations. These I have never considered it necessary to increase in the least; in fact, in one work I am now carrying out on your principle I even reduced the depth, and on a site of which I had a little apprehension.—From the confidence I have in the perfectly horizontal bond and tie given to the walls, I am satisfied that in the Oxford and the Gloucester and Bristol Training Institutions (both stone buildings) I derived much greater advantage than if I had adopted the common mode of timber floors.—2ndly. As regards a greater chance of smoky chimneys, I have been singularly fortunate in all the buildings thus constructed, and I can refer you to the Convalescent Hospital at Walton, where not a single chimney smokes out of nearly fifty, which have been in operation for months, even before the building was complete, that it might be ready for the patients.—As to the 3rd objection, that the ceilings are apt to fall, I have carefully examined many hundred squares executed on your principle, and I do not find the slightest tendency of the kind.—I am so fully convinced of the value of your invention, that I am prepared to recommend it, particularly since the adoption of wrought-iron, for every class of building."

2. *A communication from* Mr. Rhode Hawkins:

"There are three points on which you ask my opinion of the fireproof floors used at the new buildings at Guy's Hospital. 1st. With regard to the necessity of using more solid foundations in consequence of the increased weight of the floors. I have to say, that though your floors are heavy as compared with ordinary wood floors, yet as the weight of the floor is after all but a small portion of the whole weight which a foundation has to carry, I do not think that the extra weight should be considered for a moment. As to the necessity of additional ties to the walls, if the girders and joists are of sufficient strength, the weight will be conveyed directly on to the walls, and resolve itself into a mere crushing force, and ordinary brick walls are competent to carry five or ten times the weight which is generally put upon them.—With regard to the ceilings, I have only to say, that at Guy's Hospital I know of no ceiling having given way; the key seems to me to be a very strong one, and I see no reason to apprehend any accident of the sort. The ceilings have been finished nearly a year and a-half, and are perfectly good now. —With regard to the floors causing smoky chimneys, I have little to say, as I have not tried the plan in an ordinary dwellinghouse. At Guy's Hospital the smoke is carried in a long smoke tube into a lofty shaft where there is a considerable draught, and none of the chimneys smoke; but I must add, that I think that where it is necessary to supply air to the fireplaces, it should be done as a system, and not left to the chances of drawing the air through the floors, and with it a large quantity of dust and dirt."

3. *A communication from* Mr. R. W. Armstrong:

"In reply to your query, whether I deemed it necessary to go to extra expense with the foundations of the buildings in which I introduced your patent fireproof flooring, beyond that which I would have done had I used timber floors, I beg to say, the buildings in which I used your system of flooring being for factory purposes, I considered it expedient to provide foundations sufficient for any emergency, and therefore did not allow the fact of the floors being heavier than timber floors to influence me in any way. As to the broad question for buildings in general, much must depend on the number of floors and the proportion of bearing points to the void or area to be supported on those points, but I think few would venture to erect buildings with timber floors on foundations that would not be equal to the sustaining of the additional weight of floors constructed on your principle, as in my opinion it would be narrowing the point far beyond the limits of practical application. I have not in any instance found it necessary to introduce any additional 'ties' for the floors than that given by the joists."

4. *A communication from* Mr. Thomas Piper:

"The result of my experience with floors constructed on your principle is, that no additional foundations or ties are required beyond what would be requisite and necessary for good building on any principle. That the ceilings are not more liable to fall than ceilings on laths in the ordinary way—indeed, I cannot charge my memory with any instance of a ceiling falling in any of the works carried out on your plan. As to smoky chimneys, they are no novelty unhappily, and though the tendency of the greater accuracy of all building operations is unquestionably to limit the supply of air, and so retard the escape of smoke, I have noticed no difference between what occurs with your floors and a thoroughly good wood floor of the ordinary construction, pugged in the usual way."

5. *A communication from* Mr. Brandon:

"Has never had cause to increase the strength of foundations, or the walls, or ties in the walls. Has never known any defect whatever in the ceilings, except an occasional very minute crack, such as might be found in those of the ordinary construction, perhaps ten or twelve such in a building containing 800 squares, and has never known an instance of chimneys smoking."

Mr. Barrett continued — With regard to the time required for the floors to dry, it depended on the season, but they were always dry as soon as the walls and plastering made it safe or prudent to occupy the building; at some floors lately constructed at Windsor Castle, the rooms were occupied in six weeks from the receipt of the joists. The house in the Adelphi referred to by Mr. Christopher, was begun in April 1850, and though it was a large building containing nearly thirty rooms, and lying close to the river, it was occupied in March 1851, although there had been several delays. The peculiarities of the other building he referred to should have been stated: it was in a hollow, with lofty buildings at the back, two high flank walls, and a narrow mews in front; there was in fact no possibility of establishing a current of air through it, even if its construction had admitted; but the fact was, that out of forty-two rooms, only eighteen had fireplaces, and the twenty-four rooms which were without fireplaces were all so constructed that there could be no current of air through them, and twelve of them were lighted only from the staircase. These circumstances were quite sufficient to account for its taking a longer time than usual to dry. With respect to ventilation and artificial warming, it was quite true that facilities were afforded by the system, if those adopting it would avail themselves of them; but that they were more *necessary* than in the common method was not the fact; and as regarded loss of draught to fires by the floors not affording a supply of air, it struck him that this was rather an advantage than otherwise, as cold draughts to the feet and legs were always objectionable; indeed Mr. Christopher himself had been one of the first to point out this as an advantage of the system. Certainly this had never been complained of by any one else, and numerous inquiries had satisfied him that the complaint had no real existence. In speaking of Northwoods, Mr. Christopher had stated that "regarded simply as a residence, it was most comfortable." And so satisfied were the Metropolitan Association for Improving the Dwellings of the Working Classes with this system of construction, in one of their buildings containing 186 rooms, that the Secretary had written as follows:—

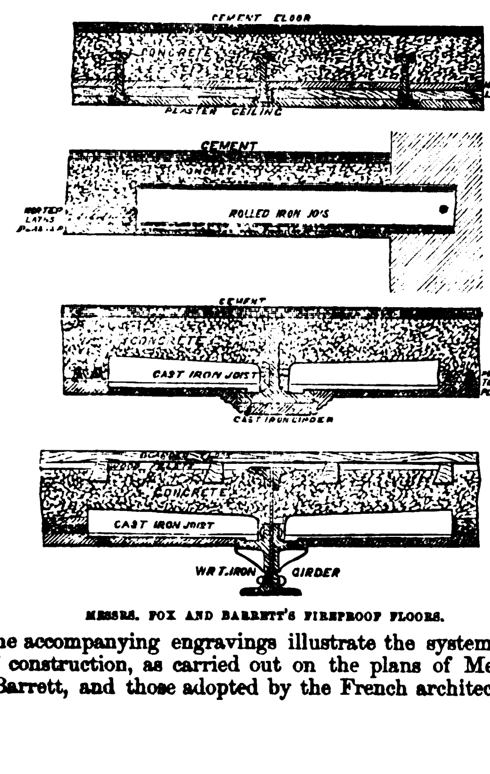
6. *A communication from* Mr. Gatliff, *Secretary Metropolitan Association for Improving the Dwellings of the Industrious Classes.*

"In reply to your inquiry as to the success of your fireproof flooring in the 186 rooms in which it was used by the above Association, I beg to say that an accident not having occurred to test its qualities in that particular, I cannot say more than that from the opinion I have formed, I should recommend its adoption in between 300 and 400 more rooms about to be constructed by this Association in Guy Street, in the Borough of Southwark, and more especially from its being *sound*-proof, which we find a great inconvenience from, in about the same number of rooms in the Old St. Pancras Road."

It was stated in the Ninth Report of the Directors of the above Association, that in the family dwellings above referred to, providing accommodation for sixty families, not a single death had occurred in the course of the preceding year, out of an average population of 300; a circumstance which may be presumed to indicate that the system is not without its advantages as regards the health and comfort of the occupants: and besides the circumstance of the building being fireproof, the Association has found that on certain other points this system of construction possesses advantages which are of much importance in buildings of this character, being "very instrumental in preventing the travelling of sound from floor to floor, of vermin, of offensive smells, and of the filtration of water in case of accident from the overflowing of cisterns or otherwise." These floors had a boarded finished surface. These facts he thought rather indicated that the system was advantageous as regarded the health of the occupants of the buildings, and this could not be said of smoky and ill-ventilated dwellings. The alleged necessity for better foundations and ties, was perhaps best met by the letters already quoted: they were not provided in the five-story building mentioned at the last meeting, nor at the large Hotel at Carlisle, lately erected by Mr. Salvin; and he referred particularly to these two works, because the plans of both were originally prepared for timber floors, and no alterations were made by the introduction of the fireproof system; nor could he find that they had been increased in any instance. In the original building at Northwoods, and many others, no ties whatever were provided. As to the License, although the charge was rather for the information supplied, yet it could easily be shown that it was soon repaid by the saving in the fire-insurance. This saving on the building in the Adelphi was 4*l.* 10*s.* per annum, repaying the charge in less than seven years, and after that time becoming an annual saving to that extent in perpetuity. The charge for cutting and trimming joists was certainly an error, as the castings were not adapted for trimming; the building had been altered during its progress, and some little expense might possibly have been incurred on that ground. The painting of the joists was by no means necessary. Upon the question of cost, Mr. Christopher had stated that the estimates were not to be depended on, and he had given a calculation of his own, making additions, to every one of which he, Mr. Barrett, altogether demurred, and for which he had shown there was no foundation, as they had not been incurred by any other architects. The figures he had originally given (*ante* p. 92), spoke for themselves, and showed the cost with the iron of the strength he usually employed, and also of that used in Paris. He did not however recommend a reduction to their standard, but had stated that some reduction might very safely be made, and he had actually had floors constructed with joists 25 per cent. less in strength than those which formed the basis of his calculations, and with perfectly satisfactory results. He had no doubt whatever that the joists he used were much in excess in point of strength, and he was confirmed in this view by the fact that those of extra strength described in Mr. Burnell's tables as employed at the Louvre (*ante* p. 95) were not so strong as those he had employed for ordinary dwelling-houses. Mr. Christopher's conclusions were therefore altogether erroneous as to the possibility of reducing the strength, and the cost of the iron work fixed Mr. Barrett had actually reckoned at 10*s.* per ton more than the price at which it had been lately undertaken. The cost of the roof, the cement covering of which had failed, was according to Mr. Christopher's own statements as follows:—"The roof with ceilings and cement surface had cost 74*l.*; while an ordinary slated roof with ceiling, would have cost 232*l.*; and a lead roof would have cost 300*l.*" If the cost of an additional covering of metallic lava (40*l.*) were added to the cost of the roof with a cement surface (74*l.*) the total cost would be 114*l.* against 232*l.*, showing a saving of 118*l.* or 3*l.* per square on the quantity of flooring in the building. Mr. Christopher had stated that the object of this discussion was to ascertain the truth, but this could only be done by the *whole* truth being stated, and that Mr. Barrett must contend had not been done in the several objections he had raised.

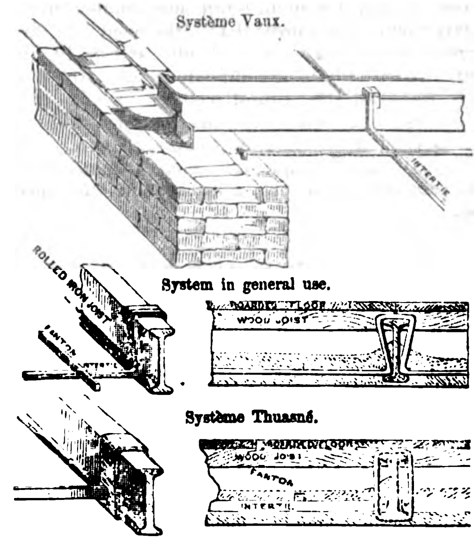
Mr. Scoles inquired whether concrete had been really found to be fireproof, and stated that a large mass which he had put into an ordinary fire had crumbled entirely in less than five minutes.

Mr. Barrett argued that this was not a conclusive test, indeed the plaster slabs mentioned by Mr. Wyatt at a previous meeting would have been destroyed under similar circumstances. It was in evidence that his concrete floors would be protected by the plaster ceiling, and where injury had arisen it was only by the long continued action of fires made for drying the plastering of the walls.




MESSRS. FOX AND BARRETT'S FIREPROOF FLOORS.

[The accompanying engravings illustrate the systems of fireproof construction, as carried out on the plans of Messrs. Fox and Barrett, and those adopted by the French architects, which have been fully described in the papers read by Mr. H. H. Burnell and Mr. Barrett, and in the subsequent somewhat lengthy discussion.]




FRENCH METHODS OF CONSTRUCTING IRON FLOORS.

Mr. Papworth observed that in his opinion no really fireproof floor or roof had yet been mentioned. An Obelisk erected in 1776 on Putney Heath, by order of the Corporation of London, commemorated the satisfaction felt by committees of that body with experiments made in 1776, described in a pamphlet, printed in 1785, and entitled "an account of the invention and use of fire-plates for the security of buildings and ships against fire." The author, Mr. David Hartley, was Member of Parliament for Hull. A reprint with additions by his nephew in 1834, stated that "resistance to every possible degree of fire, such as distillers' shops, or turpentine warehouses, may be accomplished by applying the fire-plates above and below the timbers with dry sand or rubbish between them: in experiments repeatedly tried with this double application, the room was filled from the floor to the ceiling with faggots and pitch and tar. As to common dwelling houses; when the single application of the fire-plates was used in the experimental house, where also air bricks were provided to the floors, the trials were continued from day to day to the same part of the ceiling and timbers of the house a great number of times after the plasterwork was burnt down and destroyed, but the timbers could never be set fire to, so as to burn of themselves, nor could the fire ever spread sideways; as long as the burning faggots were applied to the timbers, they were charred perhaps to the depth of an inch of their substance, but the fire-plates over them acted as an unconquerable extinguisher, preventing them from taking fire and burning of themselves." Rolled copper-plates are specified as well as those of painted iron; tinned or galvanised iron or zinc would be equally applicable. In 1774, the sum of 2500*l.* was voted to the inventor by the House of Commons, and in 1777, the patent was extended for thirty-one years from that time. The experiments he made however, showed that the only way to check a fire was to prevent the access of air; for flame would inevitably calcine such materials as concrete and plaster.

Mr. H. H. Burnell explained, that although violent and long continued heat would destroy the French floors, yet the earthenware pots would be a great impediment to the spread of any moderate fire.

Mr. Tarring said, that in the West of England where concrete or lime-ash floors were much used in common houses, the concrete failed or became rotten in the parts nearest to the fireplace, but when formed of lime mixed with sand and hair, it would last longer in that position than when composed of gravel. Plaster ceilings would resist fire, but cement would not, as that material soon yielded to heat. In old malt-houses in the West of England, with concrete floors 5 to 6 inches in thickness, he had seen the walls though built of stone 2 ft. 6 in. to 3 feet thick, bulged out three to four inches on each side by the expansion of the concrete.

Mr. INMAN (the Chairman) reminded the meeting of the different effect which fire would produce on timber and on metal, from the former being a nonconductor and the latter a conductor of heat. Such effect should be guarded against in a fireproof construction, so that the metal might not conduct the heat to the wood. Experience had shown that in the event of a fire breaking out, the grand object was to get it under within the first quarter of an hour, and to aid in accomplishing this, the Building Act had wisely restricted the cubical contents of each division to be separated by walls in warehouses and similar buildings.

At the suggestion of the Chairman, the vote of thanks was extended to all the Foreign and English gentleman who had furnished remarks upon the subject, and the meeting then adjourned.

NOTE.—Mr. Christopher thinks that the apparent difference in the testimony borne by Mr. Wyatt and by himself in reference to Fox and Barrett's patent may probably be explained by the fact that Mr. Christopher's experience has been almost wholly confined to London, while Mr. Wyatt's appears to have been restricted to the country. In London the frequently disturbed state of the soil and the height of the buildings require *extra foundations*, while the numerous windows, confined to the backs and fronts with small piers of separation, and many difficulties of construction, demand *extra iron* bonds. The long unpierced party walls, the contracted areas at the backs of the houses, and the want of sun in front, retard the drying, while the same causes, coupled with the smallness of the rooms in chambers and dwellings-houses, compared with the large dormitories and corridors in Asylums will, in some measure, explain why the loss of draught to the fires from the absence of hollow floors and partitions is so felt in these solid houses. Mr. Christopher thinks that none of these difficulties would occur at Northwoods, situated in the midst of a park, or to the buildings which Mr. Wyatt, Mr. Clark and others, have superintended in the country. Mr Christopher wishes to state that neither pains nor expense were spared to secure the most perfect execution of the buildings carried up under his superintendence in respect to materials and workmanship.

## PROGRESS OF MECHANICAL SCIENCE.*

WHILE the Mechanical Arts have progressed more rapidly during the present century than during any other, the development of the Science of Mechanics has been by no means co-extensive. The magnificent structures which the present generation have seen commenced and completed—the admirable works of modern engineering which have so largely increased the value of our island for all the economical purposes of life—the beautiful machinery and apparatus by which raw materials are converted, with almost magical transmutations, into delicate fabrics and products wrought with the most refined precision—all the greatest results of modern industry, have been created by mechanical contrivance and experiment, little aided, it must be confessed, by science.

In making this observation, we intend the word *science* to be taken in its true sense—*systematic knowledge.* The word is apt to be much abused. There is scarcely a speculative inventor or enthusiastic patentee who does not arrogate to himself the title of a scientific man. Unless newspaper reporters be fallible, there is never a vessel launched, never a screw propeller receives a fresh twist, never a new fire-escape rescues people from houses not on fire, never a fire-extinguisher subdues a prepared conflagration, but "scientific gentlemen" are present to witness the exploits. Let us not be supposed to underrate these essays. Doubtless, they are often useful and afford valuable suggestions, but it is by a misnomer only that they can be said to be scientific pursuits. The knowledge of experimental facts, however numerous, varied, and subtle, does not constitute science until it become systematic and exact. A man may be acquainted with all the forms of screw propellers which have been ever devised—he may know the measures of all their strange contortions—the names of their sanguine inventors, and, better still, the results of trials of them,—but without method, his knowledge is not science.

We have observed a test, nearly unfailing, which distinguishes merely accumulated knowledge from that methodised knowledge which constitutes science, properly so called. So long as the facts of any subject are undigested and its principles speculative, it is without a *nomenclature.* Vague expressions are applied to the different parts of the subject because the knowledge of it is vague. The so-called "principles" are little better than guesses, and if examined closely will be found to be clothed in a language so loose that they elude the grasp of true philosophy. We smile now at the old adage, "Nature abhors a vacuum;" but have we not similarly figurative adages seriously promulgated at this day respecting various branches of mechanical knowledge—as, for example, the laws of fluid motion? A maxim can have no claim to scientific accuracy so long as it retains the slightest trace of *metaphor.* In the adage just quoted, Nature is metaphorically represented as actuated by dislike. So again, Lagrange slipped in his celebrated proof of the Principle of Virtual Velocities, by representing gravity as an *endeavour.* Again, tomes of unnecessary discussion might have been spared if some old philosophers had not distinguished force into two kinds—living and dead—*vis viva* and *vis mortua*, as they were figuratively termed,—concerning which the controversy was not settled till the metaphor was abandoned. Many like instances are to be found in the early researches of every science. Alchemy and Astrology were full of them: when those pursuits were divested of the slough of metaphor, they became the noble sciences of Chemistry and Astronomy.

But it is not enough that the language of a science be free from figure—it must also be technical; that is, particular words must be devoted to single meanings. For this necessity there are two reasons,—first, in ordinary language inconvenience continually arises from one word having several meanings; and this ambiguity, which in conveying the simple thoughts of every-day life is merely inconvenient, would, in expressing the abstruse results of prolonged investigation, be absolutely fatal to accuracy. Secondly, the language of every-day life, for obvious reasons, frequently affords no means of expressing such results, and the deficiency has to be supplied by the invention of new words. From these considerations, then, it appears very manifest that a precise and methodic nomenclature is generally a test by which knowledge may be distinguished from science.

It is worth while to examine the reasons why mechanical science has made recently so slow progress as compared with the practice of mechanics. The reason cannot be that the tendency of our age is averse from exact philosophical investigation. On the contrary, in many other departments of science the progress of knowledge has never been so rapid as in the present century. The growth of the sciences of chemistry and geology has been almost exclusively confined to the last fifty or sixty years; and, during the same period, astronomy, physical optics, and pure mathematics have received some of their most important developments. But if we turn to the science of practical mechanics, we shall find in most of its branches numerous important problems the solution of which the practical engineer in vain demands of the theoretical philosopher. Who knows how to determine with certainty the proper form of a ship under different conditions of speed and loading? Who can determine completely the strength of an arch or suspension bridge subject to dynamical forces? Who the influence of the motion of steam on its pressure, and the consequent relation between the pressure in the boiler and cylinder of a steam-engine? Who the relation between the resistance to and the velocity of a railway train? Who the internal forces of friction in a deflected beam? Who the effect of a screw propeller of given form and dimensions, and rotating with given angular velocity?

These and many other questions, of which the answers would be most valuable and important additions to the knowledge of practical mechanics, remain for the present not merely unanswered but unanswerable. Take, for instance, the question just suggested respecting the forms of ships. We have not the slightest hesitation in asserting that in the present state of knowledge of the laws of fluid motion, the solution of such a problem, or even the simplest cases of it, is utterly and hopelessly impossible. Yet Nature effected the solution long ago in an infinity of ways. Fish, of divers forms innumerable, dart through the waters without noise or commotion, and direct their courses with an ease and rapidity—and the sea birds breast the waves with a stability and buoyancy—which human craft cannot rival. Nature then teaches us that our efforts fail because they are inadequate, not because they are directed to unattainable objects.

To ascertain why the desiderata of practical mechanics are yet unattained is obviously the first step towards devising new means for their attainment—or at least, towards estimating the probability of their attainment. Let us then see first what kind of advantage science has already afforded to the practical engineer and mechanic. Mechanical science consists of two distinct parts—experimental laws, and methods of applying them deductively. The experimental laws are inferred from a multitude of observed results by a process of induction which eliminates circumstances repugnant to the conditions assumed. For instance, the general

* 'A Treatise on Analytical Statics.' By I. TODHUNTER, M.A., Fellow and Assistant Tutor of St. John's College, Cambridge. Cambridge. 1853. Crown 8vo. pp. 318.
'The Steam Engine for Practical Men.' By JAMES HANN, A.I.C.E., and PLACIDO and JUSTO GENER. London: 1854. 8vo. pp. 240.

laws of equilibrium and motion are essentially founded on simple principles respecting action and reaction inferred from experiment, but not actually obtained from it, because nature presents no example of complete rigidity and complete equilibrium. These principles are so simple as to appear mere truisms, and yet so fertile that on them are based those magnificent systems of investigation—Statics and Dynamics. But the fertility of these principles, great as it is, is not unlimited, and moreover they are inferred, as we have said, by the abstraction of various extraneous circumstances. Consequently, the systems of Statics and Dynamics are limited two ways—first, they may require the abstraction of circumstances too important to be negligible; secondly, even with all the assistance which such abstraction affords, these systems may be insufficient for the solution of complicated problems.

Now, both these cases occur in practical mechanics. It is continually requisite, on the one hand, to consider molecular forces and displacements which Statics and Dynamics originally neglected; on the other hand, it is requisite to investigate the operation of forces of which the number alone affords an insuperable difficulty to their investigation, by the fundamental principles of mechanics. What course, then, is open for the remedy of the deficiencies in question? Clearly the extension of the science must depend on the establishing new experimental laws, or the improvement of the methods of applying them. The latter task belongs to the mathematician; it is the former which belongs to the experimental philosopher, and with which we are here chiefly concerned—for here, as we apprehend, is the great defect in our efforts to advance mechanical science.

Is there not, then, it will be asked, sufficient zeal for experimental research? There is doubtless much zeal, but it is not guided by adequate knowledge. Mechanical experiments are almost universally made to test directly the value of some invention, or to ascertain the powers of some machine, material, or structure—rarely to obtain inductive laws. The impatience of the experimenters is not satisfied except by *direct results*; the far more fruitful knowledge, for want of which mechanical science stands still, he despises as abstract, and not practical.

This explanation, if correct, is quite sufficient to account for the slow progress of mechanical science. The view we take of the question before us is this: that the very knowledge which is really wanted, experimenters almost universally neglect as valueless; and the reason why they neglect it is, because the use of it is indirect, and they have not the scientific knowledge which would enable them to perceive its use and value. As this matter is one of importance, let us endeavour to illustrate our meaning by reference to an example. The strength of a beam depends of course on its elastic forces, and these are of several kinds. There is the linear elasticity, resisting change of figure by longitudinal extension or compression; elasticity of rigidity, resisting change of figure by torsion or tangential displacement; cubical elasticity, which resists change of volume by increase or diminution of density. Now the knowledge of the relations of these elastic forces to each other, and to the displacements by which they are accompanied, is precisely the desideratum, at this time, for the completion of the science of the strength of materials. This knowledge, alas! is also precisely that which, in experiments upon the strength of materials, is most generally avoided. We have volumes full of details of *direct* experiments performed by bending or stretching rods till they break; and the information so gained is valued as practical because it is direct. But the more potent machinery of investigation, by seeking for laws first and applying them afterwards, is discarded because it operates indirectly. Were the experiments on extension or deflection of iron multiplied to ten times their present number, they would afford no aid for computing *the strains of torsion of the vertical sides of such a structure as the Menai tube.* At present, the absence of knowledge on that subject is almost complete.

The proverbial principle, that the shortest road is often the longest way about, is amply illustrated with respect to mechanical science in many other cases. For instance, the investigations of the effects of screw-propellers are as crude and undigested as they can be easily conceived to be. The proper course in this, as in other mechanical investigations, would be, that the experimenter and the theorist should *co-operate,*—each communicating the desiderata of his knowledge to the other. But this kind of co-operation is rarely attempted: consequently the experimenter pursues a course of experiment which from its very nature is *interminable,*—heaps together facts either altogether barren, or else fruitful of mischief only, because they suggest hazardous generalisations; while the theorist gives up in despair the solution of problems of immense practical importance, and wastes his strength on mere mathematical puzzles.

We cannot help thinking that the evils here insisted on as the true causes of the slow progress of the philosophy of engineering might be remedied in a great measure by the influence of the valuable Societies whose purpose it is to promote the advancement of mechanical art and science. It is difficult to imagine a more admirable field for the display of the utility of those Societies, than that which they would occupy by encouraging the pursuit of theoretical and experimental investigations by the method of the division of labour. There are many able mathematicians who would readily address themselves to the solution of questions respecting which every practical engineer feels the necessity for more knowledge, provided that the requisite experimental data were furnished. On the other hand, many engineers and mechanicians, who now exhaust their energy in most unproductive experimental investigations, would gladly address themselves to the task of furnishing such data were the value of them properly explained. At present, it is the practice of the Societies in question to encourage investigations having immediate and direct results. This course is the most attractive, but we doubt whether it be the most provident or effectual. It indicates a deference to the impatience of those who are unwilling to follow the devious paths by which scientific knowledge is most frequently obtained, or to the distrust of those who are ignorant of the enormous powers of mathematical investigation. By the powers of mathematics, difficulties have been overcome of which the vastness is not to be comprehended without long study, and results attained which had else been unimaginable,—the depths of the heavens measured; the myriads of whirling orbs which rush through space with far swifter than eagle's flight, marshalled in prescribed courses; the most complex motions and perturbation of the heavenly bodies investigated and predicted with unfailing accuracy; the marvellous phenomena of light explained by processes of extraordinary refinement.

The methods of investigation by which such magnificent results have been obtained have proceeded universally on those principles of co-operation and division of labour, here insisted upon as the most effective for the extension of mechanical science. Familiarity with the discoveries of Newton has not abated the astonishment at his marvellous powers of penetrating the secrets of nature. Yet even the intellectual powers of Newton would have been baffled by the difficulties in his path, unless way-marks had been previously placed in that path by the hands of the experimental philosopher. How many long years of unwearied toil did it cost Kepler to achieve for himself the glorious title of Newton's precursor! The laws of the movement of the planets about the sun, known as *Kepler's Laws,* were deduced by that indefatigable astronomer by observation alone, and often-repeated, often-disappointed, attempts to reduce his results to regular laws. In these discoveries he was aided by no mechanical principles: he contented himself with observing and systematising, without attempting to theorise. Nor was the full importance of his discoveries perceived until Newton applied them to determine the force which keeps each planet in its orbit, and demonstrated that the law of gravitation, which indicates the direction of each such force and the variation of its intensity, is the necessary consequence of Kepler's Laws. In like manner the path of the mathematical investigator of the phenomena of light was smoothed by a long course of antecedent experiments. Many of the mechanical problems of which the engineer now vainly desires the solution, difficult as they are, can hardly be considered so difficult as those optical and astronomical problems which have been successfully solved by the course of investigation just pointed out; and we cannot reasonably doubt that the same success would attend inquiries respecting practical mechanics, if the like method of systematic investigation were substituted for the immethodic and desultory inquiries by which, at present, mechanical investigations are almost universally characterised.

Beside the methods already pointed out for promoting the advance of mechanical science, there is another, to which our limits permit only a very brief allusion. The conclusions of mathematics are often far more exact than practice requires, and that very exactness necessitates the use of excessively complicated formulæ. In the present state of knowledge, science would, we submit, be often more usefully employed in determining *relative* than *absolute* results; that is, in *comparing* the efficacy of different modes of constructing, than in determining positive rules for calculating the powers of particular machines and the strength and stability of particular structures. Where, however, such calculations are required, it would be desirable that attention should be more frequently directed to ascertaining *superior and inferior limits*, within which the results must lie. We are justified by experience, and a knowledge of the imperfect state of mechanical science, in concluding, that what it apparently lost in precision by such a course of investigation, would be far more than compensated for by increased security of the accuracy of the conclusions so obtained.

It is time however to turn from these topics, important as they are, to the consideration of the works of which the titles are appended at the commencement of the present article. We have chosen these two works for notice here, because they are as excellent examples as could have been well selected of the efforts of the theoretical and the practical philosopher, to facilitate the acquisition of knowledge of their respective subjects. Mr. Todhunter's work is intended as a manual of the mathematical principles of statical science, and is characterised by that clearness of enunciation and precision of demonstration which constitute the real aids of the student of any exact science. Commencing with a perspicuous explanation of the fundamental principles of mechanics, he proceeds to discuss successively the laws of the composition and equilibrium of forces acting upon particles and upon rigid bodies, to investigate the analytical theorems respecting centres of gravity, the effects of simple machines, the laws of friction, the equilibrium of catenaries, the laws of attraction, and the principle of Virtual Velocities. To each chapter, by a useful arrangement, are appended numerous interesting examples for the self-examination of the student. The demonstration of the Parallelogram of Forces adopted by Mr. Todhunter is that of Duchayla, which proceeds on the assumption of the law of transmissibility of statical force in bodies at rest. The laws of the equilibrium of a *point* ought however, we apprehend, to be independent of all experimental results, and to be deducible solely from geometrical considerations and the definition of the measure of forces. Duchayla's proof is open to the objection that it imports an extraneous consideration—molecular action—into the demonstration of a principle which intrinsically has no dependence on molecular action. We perceive, also, that Lagrange's proof of the principle of Virtual Velocities is inserted. Now, it appears a bold assertion, but it is indubitably a correct one, that Lagrange's proof is essentially vicious. His statement (p. 308), "since the weight always tends to descend, if there were *any* displacement of the system which would allow it to descend, it would necessarily descend," is, we apprehend, simply untrue, for it neglects the case in which the weight is in its highest position —that of unstable equilibrium. It is true, that compared with any *indefinitely small* displacement of the system from that position, the displacement of the weight may be considered to be ultimately zero; but this is not what Lagrange asserts, nor has it ever been shown to be a consequence of his axiom respecting the tendency of the weight to descend.

It is sometimes supposed that the principle of Virtual Velocities has not been yet thoroughly proved. This we apprehend to be a mistake. The indistinctness in the ordinary proofs often arises from the geometrical and the mechanical parts of the principle not being kept distinctly separate. Nothing can be more clear and precise than the proof Mr. Todhunter gives: his separation of the mechanics from the geometry of this subject, and his treatment of these two branches of it are among the happiest of his efforts. We however venture to suggest, that a proof of the geometrical principle enunciated and assumed in Art. 252, would have added somewhat to the elucidation of the subject. One of the most satisfactory evidences of the advancement of education at Cambridge is the recent improvement of the University class-books. The perspicuous language, rigorous investigation, conscientious scrutiny of difficulties, and methodical treatment which characterise Mr. Todhunter's works, entitle him to a large share of the honour of that improvement.

The 'Treatise on the Steam-Engine for Practical Men,' by Messrs. Hann and Gener, proceeds on the somewhat novel method of applying rules first and demonstrating them afterwards. In the first part of the work rules are given for calculating the work done by steam; the velocity of the piston of a steam-engine; its resistances, duty, and rate of evaporation; the proper dimensions of the different parts of the "parallel motion," connecting-rod, fly-wheel, and the slide and eccentric levers; the mechanical effects of the safety-valve, crank, governor, indicator, paddle-wheels, screw-propellers, &c. The second part of the work contains the theoretical investigation of the rules explained in the first part. The authors condemn, as liable to occasion confusion, the method of giving the rules and the reasons for them together; yet the difficulty arising from this method seems to be merely typographical. We should be inclined to think, that if the rules were prefaced by the investigations from which they are deduced, the practitioner would be assisted in apprehending their import and estimating their value. This is however a mere matter of opinion, and not one of much importance. The rules are very distinct and clear, and well elucidated by numerical examples, so that for their comprehension little more is required than a knowledge of arithmetic. Carefully, however, as the rules are selected, it may be questioned whether in one or two instances they do not attempt more than the present state of mechanical science warrants. For instance, the enunciation of a rule for computing the centre of pressure on paddle-wheels in motion, seems a rather precipitate step, considering the doubts and difficulties in which the laws of fluid motion are involved. The rule depends on an investigation by Mr. Barlow, which is given at page 146, and is founded on "several experiments," from which he concludes that the resistance at any point of a paddle varies in slight immersions as the cube, and in deep immersions as the 2·5 power nearly of the distance from the "rolling circle." We cannot undertake to affirm that this generalisation is erroneous, but we should certainly, before assenting to it, require to know the number of the experiments and the circumstances of them.

It is very desirable, that in stating the bare results of a science for the use of those who are not supposed to be capable of examining for themselves the evidence on which they rest, the certain and the merely probable results should be carefully distinguished. Mr. Hann is too well versed in mechanical science to dispute the importance of such a distinction, and the care with which he has selected his rules betokens his knowledge of the numerous errors committed in existing treatises on the steam-engine. He has avoided the common fallacies which abound in such treatises respecting the relation of the evaporation of the boiler to the work performed by the piston, and gives a very lucid and satisfactory account of the real duty of steam-engines. The perspicuous statement of the thermal and mechanical properties of steam, and the numerous practical suggestions which are interspersed throughout the work, add much to its value and interest, and concur with its other merits to render it a very useful guide for the practical engineer. It is but fair to add, however, that Mr. Hann speaks in such flattering terms of this *Journal*, and certain scientific contributions to former volumes of it, that we may perhaps have fallen into an error which we wished particularly to avoid—that of returning compliments.

## SYMBOLISM IN ART.

Sir—In the review of my little work on Symbolism, in the last number of your *Journal*, it was said that, for a definition, "Mr. White appeals only to one of his co-sectarians, who is evidently regarded by him as an infallible authority," and that "the canonist appealed to has been pleased to define Symbolism as 'the having something in common with another by representative quality.'" Now this being the definition given by Johnson, I would venture to ask *in what way* I am to be considered as his "co-sectarian"? Not that there is anything to be ashamed of either in having one's name associated with that of the great etymologist, or in my having appealed to such an authority;—but, as very much of an argument depends upon the correctness of definitions, and your readers have been led to suppose that this one was taken (as best answering my purpose) from a prejudiced or "party" source, their minds ought, in justice both to them and myself, to be disabused of the idea. And as your Reviewer considers "the question of Symbolism in Art to be interesting to artists," he must be glad to see such an error, if inadvertently fallen into, corrected by an insertion of this letter in your next number.

39, *Great Marlborough-street*, *March* 7, 1854. William White.

## RAILROAD DRAWBRIDGE AND SWITCH SAFETY TELEGRAPH.

C. McRea, *Inventor*, Philadelphia, U. S.*

*The Committee on Science and the Arts, of the Franklin Institute (U. S.), to whom was referred for examination, a "Railroad Drawbridge and Switch Safety Telegraph," invented by* C. McRea, *of Philadelphia*, —Report:

That in this contrivance an electrical current is arranged so as to be closed when the drawbridge or switch is in proper position, and to be broken when this is not the case. The wire terminates in a rail carefully insulated from the rest of the track, and at such a distance from the bridge as to allow ample room for stopping the train of cars between them. The next rail to the one spoken of is also insulated from the track, and connected with one of the ground plates of the circuit. On the locomotive is placed an electro-magnet of the ordinary construction, whose keeper controls the works of an alarm, so that the bell, stopped while the keeper is not attracted by the magnet, is released and allowed to ring the moment that this attraction takes place. The wire of the coil terminates in metallic connection with the front and hinder axles of the locomotive. And it will be easily seen that when the locomotive reaches such a point that the fore wheels are on one of the insulated rails, and the hind wheels on the other, the electric circuit (provided the drawbridge is closed) is completed through the magnet, and the bell rings, indicating that it is safe to proceed; but if the drawbridge or switch is open, the bell will not ring, for the electric circuit is not closed, and the conductor is warned to stop or to proceed with caution.

The means proposed for obtaining this important end are simple, and not expensive, and the idea is certainly a very ingenious one; and it will be observed that the result of any failure in the apparatus is simply to excite the cautiousness of the conductor. This safety signal cannot be given unless every thing is in order. This constitutes, in the opinion of the Committee, the very great merit of the contrivance. In practice, the difficulties which suggest themselves, will be in perfectly insulating the rails, especially in low situations, and in very wet or icy weather; and, secondly, in arranging the extremities of the magnetic coil so that the current from the wire will pass through them. There can be little doubt that the grease on the well-oiled axle of a locomotive will prevent the passage of an electric current of such feeble intensity, and if it did not, it would pass through the pedestals and iron work of the engine to the other axle, and thus escape the magnetic circuit. But the avoidance of this objection will probably be easy; and the simplicity of the apparatus and importance of the result to be obtained, thereby recommend the invention to a practical trial.†

Mr. McRea has also proposed a modification of the apparatus for avoiding the collision of trains on a single-track road. At the turn-out at each extremity of the part of the track on which the trains may meet, the insulated rails are prepared as before, but at each point the line is provided with a "circuit changer," as shown in the accompanying engraving; the battery has a double circuit, each including one of these circuit changers. The ordinary position of the circuit changer is such that the current to which it belongs is interrupted. Now, the conductor of the train who first arrives at one end of the prepared track, shifts the circuit changer by a simple motion, and thus passes a current from the distant station through his magnet, and the ringing of the bell indicates that he may proceed in safety. In proceeding, he leaves the circuit changer in its new position, by which the circuit at the end is broken. If, now, while he is on the doubtful ground, the other train arrives, and the conductor shifts the changer at that end, he can get no circuit, and, consequently, his bell is silent; for it will be seen by the engraving that the current must come from the far station, and that has been thrown out by the first train in passing; he must therefore wait. As the trains pass off the ground they must stop to readjust the circuit changers in their first positions. It will be seen here again, that any failure of the apparatus, or negligence in its adjustment, can only produce delay, and that, provided the first conductor performs his duty, a collision is impossible. These changes may, it is manifest, be easily made by the locomotive itself, if that be deemed desirable.

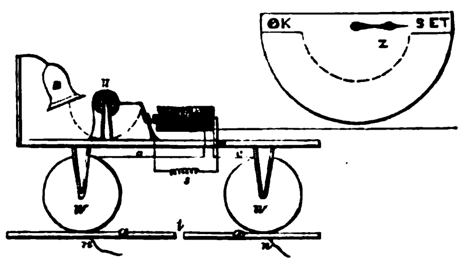
By order of the Committee,

*Philadelphia, October 15th*, 1853. W. Hamilton, *Actuary*.

### *Description by the Inventor.*

The mode of arrangement is, to extend a wire from a battery across the drawbridge, to a safe distance on each side, and there connect to an insulated rail in the track. When a train of cars approaches the bridge from either side, so that the wheels *w*, *w*, fig. 1, touch the track *a*, *a*, at opposite sides of the insulation *i*, if the draw is closed, a circuit will be completed; *n*, *n*, are the wires which extend from the battery and connect with the track; *c*, *c*, are wires which connect the circuit from the wheels to the electro-magnet *m*. When a circuit is formed, the armature *x*,

Fig. 1. Fig. 2.



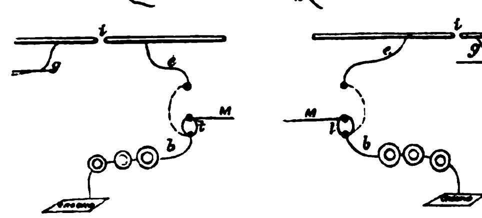



Fig. 3. Fig. 4.

will be so attracted as to release the hammer *y*, which will be acted upon by the spring *u*, so as to strike the bell B. The shaft to which the hammer is fastened carries with it the hand *z*, as seen upon the index in fig. 2, so that when the circuit is closed the hand will point to "O K." When the circuit is broken the armature will fall into its former position by aid of the spiral spring *s*, when the hand of the index is to be turned back to "*Set*," by which the instrument is adjusted for use. If the draw of the bridge be open when a train approaches it, the circuit will not be completed in consequence of the separation of the wire at the draw; therefore, the bell cannot ring, and the hand on the index will remain pointing to the word "*Set*." The same plan of galvanic connections, as also the same instrument, are applicable to the prevention of accidents at railroad switches; as by the displacing of a switch, the same effect may be produced upon the galvanic circuit as by the opening of a drawbridge. By means of a different plan of connections, the same apparatus may be used for the purpose of indicating to persons on board of one train as to whether an approaching train has passed a given point of the road or not. Figures 3 and 4 represent prepared places in the track, as seen in fig. 1; *g*, is the ground wire leading from the track on one side of the insulation *i*; *e*, is a wire which is attached to the track, opposite the ground wire, and which forms part of the main line; when the circuit changer *t*, is removed from the battery wire *b*, and placed so as to connect it with the wire M, which extends to the next turn-out.

On the arrival of a train at one of the prepared places, by shifting the circuit changer *t*, from the point where it connects with the battery wire *b*, so as to connect with the wire *e*, a current will be passed through the magnet upon the car from the battery at the distant station, causing the bell to ring, which indicates that they can proceed in safety. The circuit changer is to be left in its new position, so that when the approaching train arrives at the next turn-out, no circuit can be obtained, which indicates that said train must wait. As the trains pass off the ground, the circuit changers must be placed in the original position.

* From the 'Journal of the Franklin Institute.'

† As soon as these objections were proposed to the inventor, he suggested a mode of obviating both of them by terminating one end of the magnet coil on a rod projecting downwards from the cow-catcher, the other in a rod projecting similarly from the hinder frame of the engine, and setting the insulated rails in the middle of the track where they can easily be completely insulated. It would also be advisable that a signal should be given to the switch or bridge tender, to prevent the possibility of his opening the switch or bridge after the engine had passed the signal station, but before reaching the point of danger.

## ON ANCIENT AND MODERN METAL-WORKING AND ORNAMENTATION;

### WITH SOME ALLUSION TO THE ART OF NATURE-PRINTING.*

By W. C. Aitken.

[*Paper read at the Society of Arts, February 15th.*]

Before proceeding to the consideration of the more immediate purpose of the present paper, and directing your attention to the various specimens displayed before you, to which I will, as occasion requires, point for the more complete elucidation and illustration of the processes alluded to in my paper, may I crave your indulgence for a very brief space of time while I introduce for your consideration a few remarks on the subject of ornament on metal work generally. I am the more anxious to do this in order to place before you in its true light the necessity which exists for gratifying the demand now universally made for articles in and on which ornament is extensively introduced. That this demand has its origin in a desire for the beautiful, admits of but little doubt; that the faculty should be educated to desire what is correct is, I think, now very generally admitted; that it has not hitherto been so, must be laid rather to the charge of those in authority over us than to ourselves. An improved and improving taste is, however, observable; attributable, doubtless, to the increased and increasing circulation of works treating on ornament as applicable to the productions of the national industry, to the slowly but surely expanding, extending, and elevating influences of our schools of design; to the exhibitions of manufacturing art in the provinces; and last, but by no means least, to the great industrial display of 1851, which had its origin under the auspices of the Society within whose theatre I now have the honour to address you.

Admitting, then, the existence of a natural desire for ornament, which is to be found alike in a civilised and uncivilised state of society, it follows as a natural consequence that the demands of the former must keep pace with the possession of the means to procure it; and the character of the supply will, in turn, manifest the capabilities of the producer and his appreciation of the taste of his customers. Experience tells us, however, that, low as some may be disposed to consider the public taste, it indicates a growing feeling and tendency in the right direction. Those who have watched the avidity with which articles of an improved character have been laid hold of and purchased, will have no difficulty in detecting the change for the better which has come over even the spirit of common things. The gaily-painted plaster cast has given place to another, in which elegance of form is more apparent; the crudely formed and vulgarly coloured mantle-shelf ornament has in turn been superseded by the delicate and beautiful Parian statuette. We have now but few China services, so glaringly vulgar in their decorations as of old; coarsely executed wood-cuts, gaudily coloured, are but seldom now to be seen hung on the walls of the dwellings of the humbler classes. The japanned tea-tray wears a more sober livery; the room paper which, ten years ago, would have been looked upon as a marvel, would now be repudiated entirely; almost every article for household use, into which the element of ornament is introduced, demonstrates an improved and improving taste;—it ought, therefore, to be our duty to consider how this requirement may be made subservient to the cultivation and elevation of the public taste, by the substitution of superior ornament to that now in use; and this may be done to a great extent through the medium of mechanical reproduction with a larger infusion of the artist into the design to be reproduced than has hitherto been the case. That such is not quite an impossibility I trust to make apparent to you before the conclusion of this paper.

If in this direction much more has been attempted than has been accomplished, it is only an evidence to my mind that those who have attempted to do so have failed because the processes they employed were determined and limited in their applications and capabilities; and that they had selected examples or designs for imitation which the human hand, with its varied and multiform movements, aided by the intelligence of the human mind, could alone accomplish. In reference to this department of the subject, it may be suggested that it might be better to dispense with ornament altogether, or apply only that which is of an exceedingly high class, and adapted to the various objects which find their way into the houses of the titled and the wealthy. Admiring the labours of the artist-workman of the fourteenth, fifteenth, and sixteenth centuries, admitting the beauty of their handicraft, I well know that such ornament as they introduced, and which it is contended by many is the only legitimate kind, could only be produced by art-workmen like themselves, and, therefore, at a cost which would entirely exclude ornament altogether from what is used by the middle and operative classes, thereby effectually putting a stop to the expansion of the ideal faculty, and inducing a puritanical and non-artistic quakerism which could not fail, if adopted, to retard our progress in matters of taste.

It has become fashionable to decry certain kinds of ornamentation in which mechanism has taken the part of hand labour. The origin of this may, I think, be traced to the ever-to-be-lamented Pugin, who has been closely followed, like every other great man, by a train of disciples, the majority of whom, it is just possible, would scarce have detected for themselves what he has pointed out and made apparent. An examination of the treasures of art-workmanship, to be found in continental collections of antiquities—chiefly, however, in the first instance, of a sacred kind and for sacred purposes—disclosed to him the peculiarities which distinguished early and middle age workmanship, and demonstrated to his mind certain principles in ornament and in construction which have since become deservedly canons, which canons have, however, been applied somewhat indiscriminately by his followers. In doing so, they seem to have forgotten or altogether overlooked the premises upon which his conclusions were founded, and that they have no parallel in England in the present day. In the middle ages, what was decorated? Only the cathedrals, churches, the palaces of kings and princes, the halls of the guilds, and the dwellings of the wealthy merchants. In the possessors of these lay, or was concentrated, all the patronage and wealth of the various countries and states. They patronised Art in order to add to their magnificence and grandeur; to gain an additional prestige, and another claim to the admiration of the multitude. This, rather than a desire to patronise art for its own sake, to rival the glories of the ancient races, whose magnificence in matters pertaining to art, history and tradition had handed down to them, the desire to emulate such magnificence, was doubtless the leading and moving principle which animated them. The few attempted to do, in the middle ages, that which the many did in Ancient Greece; there, the most expensive material upon which to work, the greatest of artists then to be found to do the work, would alone satisfy the cravings of that naturally-constituted art-appreciating people, the whole of whom were animated with the like passion for art which distinguished their great leader, Pericles. We are told, as an illustration of this, that when the sculptor, Phidias, recommended marble as a cheaper material than ivory, for the great statue of Minerva, about to be erected in Athens, it was for the reason that it was more costly, that ivory was preferred by the unanimous voice of the assembly. In Greece, as in Italy, France, and Germany, at a later period, the passion for art doubtless served an excellent purpose; for, in discussing the merits of the last newly-erected building, inaugurated statue, or coming spectacle, the people forgot their feuds and woes, personal or political; and the tyranny of their rulers, lay or clerical. On the authority of Bulwer, we learn, that with the extraordinary development of art in Athens, the dwellings of the people were not in keeping—the houses of her private citizens were simple and unadorned—the streets were narrow and irregular, and, even centuries afterwards, a stranger entering the city could not have recognised her claims as the mistress of Grecian art. This statement is peculiar, but it is important as showing that, while the patricians enjoyed within their dwellings and private grounds all the gratifications arising from objects conceived and executed under the operation of the ideal faculties,—while for them Apelles, it may be, painted a Venus, and Praxiteles chiselled a marvellous statue; while some gold or silver smith, or carver in ivory, famed for his cunning workmanship, elaborated some costly jewel or cup, priceless beyond the value of the material in the yet higher value conferred on it by its art workmanship; while some Samian potter, celebrated for the exquisite taste displayed in the very simplicity of the contour of his vases, evolved from his wheel some masterpiece of his art; while all this and much more was being done for the few, we hear of nothing being done for the many. The same, undoubtedly, holds good at a later period, when Rome and Florence luxuriated in the hey-day of their prosperity, and art reigned supreme. It was to the few, still, that art more particu-

* From the 'Journal of the Society of Arts.'

larly spoke. No doubt can exist but that the people derived much pleasure and gratification from the magnificent buildings and other works of art with which their cities abounded. We know, however, that, so far as domestic comforts were concerned, the poorer classes were very deficient—their means were small. If comfort, then, was in abeyance, much of an ornamental kind could not be expected to be found in their dwellings. Ornament belonged only to the wealthy; it could only be had by being paid for at an expensive rate. Hand labour is in all civilised countries costly; at least such labour as, in connection with intellect and the perceptive faculties, gives existence to works of art, or the higher class of art manufactures. The people were content with what they saw publicly exhibited; they imagined it was their own, and in this idea they were gratified. Not so with England and Englishmen, existing under a government which is freedom itself, with an equalisation of wealth among the various classes to which the most prosperous nations of antiquity were strangers; with the great majority of the people in possession of comparative comfort, the desire for something more naturally manifests itself among them. It is unnecessary, in the presence of an audience like the one now addressed, to explain the great cost consequent upon high class artistic workmanship being employed, and the still greater difficulty which, under present circumstances, there would be, were the demand for hand ornamented work general, arising from the difficulty there is in finding workmen in sufficient numbers and in possession of a sufficient amount of average artistic manipulative skill. It is not with us as in those countries from whence were imported the works in precious stones, metals, ivory, and embroidery in costly materials, which so deservedly attracted so much attention in the Great Industrial Exhibition. The value of labour in these, as contrasted with that important element in England will not bear comparison. In those countries a vast population exists without any adequate means of employment. There is but little to be done, and there is consequently an excess of the means of doing it. Labour is therefore cheap, and it makes but little matter how much is expended; such labour in turn becomes simply a kind of luxurious idleness. With us it is different; we live in a country of improvement and progression: what is our goal to-day will, in all likelihood, be our starting-place to-morrow. Did we content ourselves, as was the case in time past, with making, it might be all very well, but we have arrived at a higher point in the social scale.

We now manufacture, and we manufacture for the world; and, with all the defects in our manufactures, the world is glad to get them, and in this it will take no denial. Our exports increase, though we may hear an occasional growl or two here and there from an art critic, or some one who lived in the days when a common and crude thing cost double the money it does now; while some *parvenu* turns up his nose at a pretty thing, rejects it because it is common, and because he says everybody has it, forgetting that "a thing of beauty is a joy for ever," and that in nature such things as are beautiful are most lavishly provided for the gratification of man. There is another class who content themselves with finding fault without the power to mend; they abuse manufacturers without being aware of the difficulties against which that important class have to contend; and they point to the time when workmen are said to have done things for the pure love of doing them; when locksmiths delighted to exercise the utmost resources of their art on the locks they made, forgetting that now a days it is not the external ornamentation but the internal workmanship which is the more important consideration; that we make locks which cannot be picked except by Hobbs, and, more than that, that they are made in ship loads, and that the locks made in England alone serve to lock two-thirds of the doors that are locked in the world. With every desire to believe the best things of the middle-age workmen, I am quite of opinion that much of what they did, and how they did it, was the result of ignorance and want of knowledge, arising out of the imperfect state of science in its application to industry. I cannot account for the round-about way in which they went about certain things upon any other principle; we may depend upon this, that had they been acquainted with many of the processes now in use, they would gladly have availed themselves of them. I do not believe that everything they did arose from their desire to do the work for the work's sake. In doing so, I think the admirers of mediævalism have attributed to a higher sentiment that which had its origin in a lower; and I think they have not failed to detect much in the labours of the men they admire, which the men themselves never anticipated or intended. Doubtless there were enthusiasts among them as there are among ourselves; but to assume for them a superior amount of sincerity, truth, and sacrifice over ourselves, is what I respectfully submit may, with perfect justice, be questioned. When two methods exist by which the same result can be accomplished, but the one is much more economical of time than the other, we are bound by the most solemn consideration to avail ourselves of it. To select the more tedious of the two is simply to practice and encourage industrious idleness. Art is assuredly very long, and life very short; if means can then be devised to copy, either by chemical or mechanical processes, and if the copy or reproduction comes at all near the original, is it not better to employ such means to reproduce, than expend precious life in imitating only? The life of a great artist workman increases in value as his works are reproduced, his fame is extended, and he largely adds to the amount of human happiness.

How very limited our knowledge of the genius and ability of Cellini must have remained but for the copies of his works, which the discovery of electro-metallurgy has enabled us to produce and disseminate. How imperfect an idea of the celebrated cup of the great Florentine artist the best plaster cast ever gave us, and how perfect in every minute detail is it rendered by the troughs of Elkington! What should we have known of the exquisite busts, statuettes, lamps, tripods, drinking cups, and vases, with the cunning workmanship thereon, or how far did our knowledge of these extend, notwithstanding their existence in the Naples museum, and of which but for the discovery of the art of the electrotype by Spencer, many of us must have remained ignorant? These are the results of a process enabling us to secure at greatly diminished cost, copies from works whose value is priceless, and all but inaccessible to the great bulk of the people; depend upon it those who value things only as they are rare (and there is reason to fear there are many of this class to be found), behave unjustly to their fellow-men in opposing such means to an end so important. They nip in the bud the expanding and growing taste of the people. Are we then to reject every thing of an ornamental kind which is not hand-made? Are we called upon to refuse the assistance which the group of appliances which follows will afford us? Thus Cheverton's process reduces the full-size statue to a mere statuette with an ease and certainty which the unaided eye and hand could never accomplish; or Collas's ingenious process, which produced upon paper the magnificent series of French medals known as the Napoleon series; or that of Bates, an Englishman and a Londoner, who invented the patent anaglyphtograph, improved upon the machine used by Collas, and produced thereby specimens of far greater excellence and size. Need I instance, as an illustration among others, the copies of basso-relievos issued by the Art Union of London. Jordan's wood-carving machine, with a little hand labour adding the grace touches, produces results which, though certainly not equal to the works of Gibbons, are not bad substitutes in their stead, and may be accepted cordially where economy is a requisite or where limited means accompanies a taste for ornament. Where uniformity of pattern or ornament is desired, this style of work may even be preferable to that produced by hand labour. In perforated woodwork, whatever the charm of hand labour, it cannot certainly surpass the mechanical saw-piercing of Prosser and Hadley. The mechanically formed tiles of Herbert Minton are, in durability and in beauty, equal to any encaustic tile fragment dug up from among the ruins of any cathedral chancel, while they fit together much better and are cheaper. The cylinder printed room-papers of to day all but rival, where simplicity, design, and uniformity of pattern prevails, the best hand-printed specimens. The tapestry of Crace, in tone, colour, and excellence, was never equalled or surpassed by any fabric produced in a loom of the most primitive construction, or even hand-made. My conviction is, that had the middle age weavers been in possession of the Jacquard loom, they certainly would not have rejected its assistance.

I do not desire to decry the labours of the really earnest men of old, who produced much of what is worthy of admiration and imitation, but I think they and their doings have been over-estimated, while our own have been correspondingly undervalued. There is probably nothing more amusing than the contradictions which the advocates of mediæval principles display and countenance in their practice as opposed to their theory, and in their adoption of certain most unconstitutional exceptions and practices. An apostle, who out-Herods Herod in literary devotion to the cause, expresses himself as follows:—"One thing we have in our power, the doing without machine ornament and cast-iron work, all stamped metals and artificial stones, and imitation woods and bronzes, over the invention of which we hear daily exultation—all the short, and cheap, and easy ways of doing that whose difficulty is its honour, are just so many ways or new obstacles in our already encumbered road." Will it be believed, that with all the detestation of die-work and mechanical repetition, the volume in which the above eloquent diatribe is contained is ornamented by one of the processes so bitterly condemned by the writer, viz., die-work.

To make my meaning clearly understood, while I express myself thus on hand ornamentation, I do so with the most earnest desire that where there are occasions and opportunities for those possessed alike of station, wealth, and taste, to employ the highest class of talent, they will not fail to do so, and that those who may be employed will not fail in their turn to desire to emulate the glories of the ancient art-workman; let us hope that that art, that true art, which transmutes everything it touches into a thing of almost priceless value, may be appreciated as it ought; that in time to come the value of an object produced from the precious metals will cease to be estimated only according to the weight of the material employed therein; that the head which plans, and the hand which executes, may be found united together; and that the remark which has been so judiciously applied by the Art Superintendent, in his report upon Design, and in reference to works of precious metal exhibited in the French Department of the Exhibition, may be equally said, a few years hence, of the works in precious metals produced in this country, viz. "that we have regarded the material, rich and costly as it is, merely as the vehicle of the art added to it." On the other hand, we must recollect that there are amongst us great numbers of the people, who, with a desire for ornament, are not in a position to expend great sums of money thereon, so far as regards the decoration of their dwellings, or on what may not improperly be called their household gods. In ornament in things produced by man for man's use, the same liberality which is so bounteously recognisable throughout creation should be observed. Rare plants which grow in hothouses and under glass cases, of right belong to those of high estate, but for those of low degree blooms every hedgerow flower; the daisy lifts its purple eye to heaven, and the buttercup gilds the mead: they indicate, that in the mental constitution of man there exists a feeling taking cognizance of the beautiful to be gratified. Articles in which ornament is introduced should therefore be provided for every rank and condition of man who may desire them. Permit me now, therefore, to direct your attention to a few of the processes by which the end desired may be accomplished. In doing so, I will in some instances contrast the ancient and modern methods of working metal, and, so far as my time will permit, point out their distinguishing peculiarities and characteristics.

The processes employed by the earlier workers in metal must necessarily have been of a very simple kind, and, in all probability, like many of the great discoveries made by man, casting itself was simply the result of accident. Tradition tells us that the discovery of the art of glass-making had its origin in a band of Phœnician mariners, who kindled a fire on the banks of the River Belus, and being unable to find stones on which to set their pots, used, instead, some masses of nitrum: these, being fused by heat, and uniting with the sand of the sea-shore, produced glass. Is it not in like manner exceedingly probable that the art of casting had its origin in an accidental observation that melted metal, in cooling, took the form of the irregularities of the surface on which it had run? Whether this was the earliest method adopted for copying, or producing works in metal, it is difficult to determine. The sacred volume, at a period of 4000 years before the Christian era, tells us of the existence of Tubal Cain, an instructor of every artificer in brass and iron. It is, however, silent as to the processes employed by him. At a somewhat later period, B.C. 1491, the distinction between two methods of working metals is clearly made out. Thus, the artificer who was employed in the formation of the metal-work for the Tabernacle in the Wilderness, according to the command of Moses, is stated as having, among other portions, "Cast the four rings of gold, to be attached to the four corners of the Ark," by which it might be carried or borne aloft, while he made the golden candlesticks of beaten work. No doubt can exist but that the idol which the Israelites desired Aaron to make was cast; and it is singular to remark with what minuteness the process of making it is described. He is represented as having fashioned it with a graving tool, after he had made it a molten calf, or cast it: he in fact pursued the same course as is still followed—after casting, he chased or worked upon it with a graver, to render the details more perfect. In the metal-work for the Temple, built B.C. 1000, the process of casting seems to have been that which was adopted by Hiram of Tyre, the artificer employed by Solomon to do the works in brass bronze. It may be remarked, that though the words *molten* and *cast* are frequently used in the description, that of *beaten* does not appear when brass is mentioned. The pillars are said to have been cast, and also their capitals. The knobs which encircled the molten sea were *cast* in two rows, the bases on which it rested and the wheels upon which it moved were all cast. Additional evidence may be adduced as to the method adopted in casting, in so far as the materials used to cast in were similar to our own, for we are told, "In the plain of Jordan did the King cast them, in the clay land between Succooth and Zarthan." The Egyptians were acquainted with the art of casting; the Assyrians were equally so, as the discoveries of Layard prove. The Greeks had arrived at a considerable degree of perfection in the art, and tradition tells us of a Colossus, of dimensions so vast that it bestrode the entrance to the Harbour of Rhodes; it was made of brass bronze; its height numbered nearly 160 feet; the thumb was so large that few men could span it, and it took 12 years to make. There is not a more interesting history in existence than that which tells us of the productions of the great Italian artists in the art of bronze casting; the doubts and difficulties which they laboured under while the work was in progress, expressed by themselves in quaint and curious language, and the enthusiastic expressions with which they heralded their own success, and announced the existence of a new statue or group into the world of art. Who that has ever read the biography of that eccentric genius Benvenuto Cellini, but must enter into the mingled feelings with which his mind was agitated on the results of a scheme which was to stamp his future life, and, if successful, throw confusion on his imagined enemies and detractors. I here allude to his description of the casting of his group of Perseus and Andromeda, abounding as it does with clever practical hints. To those interested in Metal Castings, let me recommend that particular passage to their careful perusal. The life of Ghiberti should also be studied, as it abounds in practical details, and is a noble illustration of devotion to art; the history of the celebrated Bronze Gates of the Baptistry at Florence, wrought with so much care, so marvellous in execution, so excellent in design, uniting together in one harmonious whole, contributions from all the department of nature, representing the most momentous events recorded in Bible History, and in a language equally understood by the most highly educated, or by the unlettered lazy Italian beggar who suns himself outside. So noble are these doors, that the greatest spirit who ever ruled in the realms of art is recorded to have said, "they are so beautiful that they might fittingly stand as the gates of Paradise." A great modern, but somewhat inconsistent art critic, has expressed himself in reference to them as follows:—The rock, the fountain, the flowing river, with its pebble bed, the sea, the clouds of heaven, the herb of the field, the fruit-tree bearing fruit, the creeping thing, the bird, the beast, the man, and the angel mingle their fair forms on the bronze of Ghiberti. Forty years were expended on these doors—forty years, however, which purchased an immortality, and supplied examples to which the most accomplished artist and the veriest tyro in art may repair to examine and receive instructions in composition, in the treatment of ornament, in mechanical execution, and other details, essentially necessary to be understood, in order to produce works for similar purposes. We pass over without allusion the works of Donatello, Verrocchio, John of Bologna, and of Michael Angelo, and remark that, of late years, a decided and recognised impulse has been given to the art of bronze casting. The Exhibition of 1851 showed that we are not wholly without the power of producing castings in bronze, which are something more than creditable; and when speaking of what has been done by ourselves, let us not forget the colossal Lion of Bavaria, cast in bronze by Millar, just as it left the mould wherein it was cast; and though *not* as a bronze casting, yet, *as a* casting, the Amazon of Kiss must not be overlooked. All these are so many evidences that the art of bronze casting is not lost, neither is it likely to be.

Of the method applied for the production of a bronze statue, we may now give a brief sketch. The model being decided upon, a pit is dug of sufficient depth, and a grating fixed at some distance from the bottom; upon this is raised a rude representation of the intended figure or group, proportionably less in size, and corresponding to the hollow of the interior; this is technically called a core; after this is sufficiently dried, sheets of modelling wax, corresponding to the thickness which the metal is intended to be, is spread upon it; on this the features, drapery, and other details to be represented, are reproduced by the artist with his modelling tools. Rods of bronze or of the same kind of metal of which the statue is to be cast, are driven through the wax, and project sufficiently to pass into the outer cover of the mould. These fuse with the molten metal, and are therefore not recognised in the finished statue. From the prominent parts rods of wax are projected, which rise upwards and are intended to allow the escape of air, the presence of which is attended with danger to the workmen, and is liable to endanger the perfection of the casting. Other rods of wax indicate the passages through which the metal is to be run. The external surface of the wax model is now coated with loam or powdered crucible, ground with water to the consistency of cream, and applied by a brush all over the wax; coat follows coat until it is ascertained that a sufficient thickness is arrived at, after which clay is heaped upon this, and the whole cased with bricks, bound together by means of iron rods; heat is then applied under the grate; the wax, which represents the thickness of the metal, melts and runs out; the heat which served to melt the wax, answers the purpose also of drying the mould and expelling the damp; when covered up the top of the mould is below the level of the furnace which contains the molten metal, and which when at such a temperature as to secure complete fluidity, is tapped or opened; and the liquid metal then runs through the various channels until the mould is filled. After being allowed to cool a sufficient time, the outer coating of the mould is destroyed, and the statue stands revealed. The runners are then cut off, the core removed, and the whole is chased or finished as may be desired. In some instances, portions are cast separately and joined together by burning. This process consists in allowing a stream of molten metal to operate upon the parts to be joined together, until fusion of the two takes place, when they will be found completely united.

For small castings in metal, such as statuettes or works of an ornamental character, sand is usually employed to cast in. As this material has the advantage of allowing an escape of air, and its cohesive properties are so great as to admit of considerable liberties being taken with it during the process of moulding, it is generally preferred. Simple cylindrical articles are easily moulded; and it is only when there are figures, foliage, and deep undercuttings introduced, that the operation is attended with difficulty. This difficulty consists in judging as to the number of cores to be employed. These the workman makes upon the pattern, removing them for the purpose of lifting the pattern out; the small pieces of sand or cores are then replaced, the mould dried, closed, and held together, in order to receive the melted metal. When very great delicacy of surface or texture is desired, the ordinary sand has its capacity improved for receiving the impression by dusting upon it a very fine loam, and thereafter powdered or ground wood charcoal, the consequence of which is that the most delicate line, mat, or chase, is imparted to the sand matrix, and is in turn communicated to the casting. Patterns for ordinary plain work, either round or square, are made in the turning lathe, or by planes and chisels. Ornamental patterns of figures or foliage are in general first modelled in wax, from which a cast in lead or tin is taken; this cast is trimmed up neatly, and from it a cast is taken in brass, which is carefully smoothed up and chased. This then becomes the permanent pattern from which any number may be cast. Care and attention in this department is of the utmost importance in the economy of time, and to the ultimate perfection of the work.

I have already incidentally alluded to the fact of works in metal being produced by the beaten process, a method of working, in all probability, adopted immediately upon the malleable and ductile properties of metals being recognised. Gold and silver appear to have been first treated in this manner, the ductility and malleability of each being very great. The frequent allusion made to overlaying with gold in the Sacred Volume, indicates that some means had been found out at a very early period, in addition to casting, by which these metals could be wrought into suitable form for the purpose, viz., rendered sufficiently thin; and we receive the additional information as to this from the minutely detailed instructions given as to how the candlesticks for the tabernacles should be made, viz., of beaten work of pure gold. The Assyrians understood the process of hammering. Among the relics dug up at Nineveh was found a bronze mask, beaten out by a hammer, and various other portions of articles. The Greeks covered large statues with plates of gold, probably reduced by hammering. At a later period the art was revived by different Italian artists, whose labours are now to be seen in the various Continental museums and collections. The advantages resulting from the beating, embossing, or *repousse* method of working metals is, the great amount of effect produced, in comparison to the value of the material used—the art bestowed upon the metal creating the value, and not the metal itself. Of this class of workmanship were several of the vases made for Francis the First by Cellini; some of these, two feet in height, were raised from a single flat disc of metal; careful hammering, annealing, and a judicious selection of tools, could alone have accomplished such a result. Recently the art has been revived with singular success by the French, and those who felt at all interested in the progress of art manufacture could not have failed to remark the truly magnificent shield by Vechte, exhibited by Hunt and Roskell, dedicated to the illustration of the genius of Shakspeare, Milton, and Newton. A work equally extraordinary was that of the vase, Etruscan in form, on which, in the most delicate and also with the boldest relief, was introduced the Battle of the Titans; this vase was also raised from thin sheets of metal. Another shield, with the Slaughter of the Innocents as the subject, and produced by the same process, was exhibited by Le Page, in the French Department of the Exhibition. Morel, however, exhibited by far the most extensive application of the process, in his Equestrian Group of Queen Elizabeth, the height of which was four feet two inches, and the length three feet. It was entirely formed of plates beaten out by the hammer, which when fitted together were thereafter held in their place by soldering. We may briefly glance at this process, which, in its simplest form, may be described as follows: a proper sheet or disc of metal having been selected, the artist sketches his design on the reverse side to that which is intended to be the finished work; he proceeds to raise the various projections by a series of punches, &c. When he has obtained the necessary convexities which he thinks will give sufficient relief to the subject and will look well, he fills the back of the work up with a mixture of pitch, rosin, and sand, and attaches it to his chasing block, or ball; he then works on the convex or right side with his chasing tools, with these adding the details of features, drapery, and foilage; any roughness is removed by means of rifflers, the work is then polished and thereafter burnished, gilt or parcel gilt. In this class of art the Italian gold and silversmiths of the 15th and 16th centuries were adepts. The art was revived in France in 1838, and has ever since been practised with success. In our own country, Pugin, in his efforts to revive and improve the character, taste, and style of ecclesiastical metal work, introduced anew the art of beating up, and by this process Messrs. Hardmans produced many of their most brilliant and successful works. In connection with this part of my subject I may remark, as to the difficulties which the late A. W. Pugin had to encounter, in his self-imposed task of church restoration, among others was that of finding workmen sufficiently acquainted with the old methods of manipulation. He says: "The whole restoration has been a series of experiments; everything had to be created from the employer to the artizan; such was the difficulty of procuring operatives that I was compelled, for the first altar lamp I ever produced to employ an old German, who made jelly moulds for pastrycooks, as the only person who understood beating up copper to the old forms."

Opposed, then, to the somewhat tedious and very expensive production of works in metal, by casting or hammering, we come to the modern art of electro-metallurgy, or the deposit system, which admits alike of the creation of new, and the reproduction of old works of art, at a cost which enables men of comparatively limited means to gratify their taste. Thus we find, in the Department of Practical Art, a magnificent rosewater dish, for a sideboard, the original cost of which, if made by hand, could not possibly be less than 100*l*., but which may be had for 6*l*. 6*s*. Also a more elaborate work, of the Rennaissance period, with bas-reliefs of the Prodigal Son introduced thereon, the original cost of which could not certainly be less than 200*l*., but which may be had for 12*l*. 12*s*. The most elaborate details may be copied by this process with the most minute accuracy, while the largest work for which a tank could be made to hold a solution, and a battery of power sufficient to generate a supply of the electric fluid, would not be beyond the limits of the art. Were it necessary, another Colossus of Rhodes could be produced by its agency. The truly excellent specimens of statuary which now occupy their place in the House of Lords, sufficiently demonstrate its fitness for producing statues or groups for monumental or commemorative purposes. In the formation of a statue by the deposit process, there is not that hurry and skurry—that mental anxiety—which occasions such sad havoc in the human brain and mind. The mould, produced from a carefully executed model, is rendered conducting, and then immersed in a solution of copper. The deposition of the metal goes on while we sleep, provided the fluid is generated in sufficient quantity, and the strength of the solution is kept up. There is no anxiety as to the congealment of metal consequent on the inattention of firemen, nor the chance of bursting a furnace from the expansion of the melted metal, or the thousand-and-one accidents which perplex the caster in bronze, but, it may be, add to his delight when the statue stands revealed. Mr. Potts of Birmingham, has recently applied the art to the production of emblematic groups or relievo panels to be used for sepulchral or monumental purposes; these he places upon various coloured slabs of artificial stone or marble, &c. The result is, as will be readily anticipated, a vast improvement for the better over the memorials of the skull and cross-bones school, which are not even tolerable with the addition of an hour-glass or two, a sickle, a scythe, and half a dozen bodiless cherubs into the bargain. A word or two as to the rationale of the process will not be out of place.

Electro-metallurgy may be described as a process in which a metal held in solution is deposited in a metallic form upon some metal to be coated, or form to be copied. In the last, the cast or mould has to be rendered conducting by being coated with a metallic substance, for which the metal held in solution has an affinity. Blacklead is the substance most commonly used, but nitrate of silver is employed for the purpose when more delicate or fragile moulds are used. The electricity was generated in the early period of the art by means of a galvanic battery in various forms. The loss of zinc and other metals was, however, great, and it was finally superseded (though at times still used) by the electro-magnetic machine. This is a comparatively economical method of generating the fluid, requiring little more cost in working, save the repairs of the machine, and the cost of the engine which sets it in motion. It was at one time held that composite metals could not be deposited; brass has, however, been successively thrown down, but the cost far exceeds any advantage gained by the deposit. Gutta-percha, sealing and other waxes, stearine, plaster of Paris, &c., have been employed in the composition of moulds for internal deposits, but a recent discovery has been made of an elastic mould, which may be fearlessly left in the deposit trough without injury, and which produces the most exquisite details and the most complicated undercuttings. The mould may be removed without injury, and used repeatedly. It had been previously customary to deposit copper on a prepared mould, thereafter to destroy the plaster, and deposit a precious metal (gold or silver) therein; and to remove the copper matrix by disintegration from its more precious internal lining,—when the object desired was exposed, accurately copied even in its minute details. Large works are frequently deposited in pieces, and thereafter fitted and held together by soldering.

Somewhat akin to the beaten work of the ancients and mediævalists is the production of articles, or portions thereof, by the comparatively modern process of stamping, at least in so far as the material out of which the articles are made is in sheets: by the modern process, however, the falling blow of the stamp-hammer takes the place of the hammer of the workman. The requisites for the successful prosecution of the process are a stamp formed of a heavy piece of iron, into which the force is fastened, traversing or sliding up and down two upright bars or rods. The hammer is raised by having a cord attached to it passed over a pulley. The die is held in its place at the bottom of the stamp by four screws or poppets. The die is sometimes made of cast-iron or steel. Steel laid upon iron is, however, the most serviceable, and therefore more generally selected. The die is cut from a model which has been previously made by the artist. The die-sinker has to cut in intaglio what is in relievo in the model, that is to say, he sinks into the steel what is in relief in the model; this is done by means of chisels of various shapes and sizes; gravers and rifflers, or small files are used to put the finish upon it; it is thereafter smoothed up by abrasion, or grinding with suitably-shaped hones, or pieces of wood, of various forms with emery powder upon them. One of the conditions to be observed by the modeller or die-sinker for stamped work is to avoid entirely everything like under-cutting, as the very nature of the operation of stamping is opposed to it; when introduced the metal will not leave the die. It is very probable that the artist may feel disappointed at the difference between his model, if he has introduced under-cutting and the work produced from the die; what he has to do is to select a style of ornament in low relief which accords with this mode of production, and model accordingly. As stamping is generally looked upon as a very simple process, it may not be out of place to glance at the *modus operandi*, in order to remove an impression which very generally prevails, that it is of so simple a character as to involve in the exercise no skill whatever. The production of a stamped article is not the result of one, but a succession of blows, and the amount of force should be regularly proportioned to the cohesive power of the metal. If too great a degree of convexity is desired to be produced at one blow the metal is fractured or torn; if less than necessary the number of blows is unnecessarily increased; it is in the true proportioning of these that the skill of the workman is shown. The operation proceeds as follows:—To the falling hammer what is called a "force" is attached; the die is placed on the bed of the stamp, and held there by four screws; a piece of flat sheet metal is then laid on the die, the hammer is elevated by pulling the cord, and when at the proper height it is allowed to fall; the result is that the convexity is given to the flat metal by the blow from behind. This, in the first instance, produces a very slight effect, the metal being but little raised; this is carried through a large number of pieces of metal, corresponding to the quantity of articles required; the force is then changed, that is to say, one of greater convexity is substituted, the previously stamped pieces of metal are annealed, and, after cooling, are subjected to the routine observed on the first operation. "Force" after "force" is substituted, each differing from the preceding one in the amount of convexity; annealing follows annealing in succession, until all the details marked on the surface of the die are observable. In the production of the object now before me as many as fifteen blows have been given, consequently fifteen different forces have been used, and fifteen times has the metal been annealed. In some instances I have known as many as thirty blows required, and an equal number of forces and annealings would be necessary to produce a single article. It is in the number sold that the repayment for dies is to be expected, as their cost is very great. Articles of a globular kind are made in parts, and are either soldered or checked together. Cornices are stamped in pieces, and joined by pinning on to the wood skeleton, or they are produced in lengths by what are technically called travelling dies—viz., dies which are formed as repeats of patterns, and the article stamped is removed, after the blow, the distance between the ornament forward, and so on until the entire length of the strip is finished.

Ornamentation by means of engraving, even of average ordinary quantity, is an expensive process, comparatively speaking, and there are difficulties frequently presenting themselves in the deficiency of engravers to be found to do the work. To obviate these objections and remove these difficulties various methods have been devised; among others, those of engine-turning and damasking. The sphere of operation of these two processes is, however, very limited. Engine-turning is generally understood to be produced by a lathe, describing a succession of concentric or intertwined circles or lines. The backs and dials of watches are frequently ornamented by this method, and will afford you an excellent illustration of the effect of the process. Damasking, not damascening (a process to which the present has no similarity), is now very generally applied to the ornamenting of small metal boxes to contain supplies of those now almost indispensable little requisites, lucifer matches. This style of ornamentation is somewhat similar in its operation to the medallion engraving of Bates, which I have already incidentally alluded to. The pattern to be copied is cut round a cylinder, which is fixed in the same plane and parallel with the tube to be ornamented. A point traverses the pattern, and another in connection with it, and which moves simultaneously, cuts a line corresponding to the depressed portion of the design, leaving the raised portion of the pattern blank. The cutting point is drawn the entire length of the object to be ornamented, but only really cuts on what has been described as the raised portion of the pattern. This being completed, the tube is moved a small space, by a mechanical arrangement in connection with the machine, aud the line again scratched or cut out, and so on until the entire circumference is ornamented. The colour of the original ground arises from the varnish lacquer or bronze applied previous to the operation of ornamenting being commenced.

Another simple style of ornamentation, devised for ornamenting the tubes of pencil-cases and other small cylindrical articles, is here shown, and is produced by a series of small wheels, round the circumference of which the pattern to be indented is cut. The operation is very simple, and the pattern is produced by drawing the reeded octagon or other shaped tube through the space left in the centre of and in contact with the rollers and wheels. These revolve, and the tube receives the impression from the cut pattern. A device on their external diameter, another variety of style, is produced by giving to a round tube a spiral motion; the consequence is, that the pattern is arranged running spirally up the tube. This kind of ornamenting is, however, exceedingly limited in its application.

Where large flat surfaces and plain mouldings are introduced in the plated trade, or that of the silversmith, for surface ornamentation, engraving is commonly called into requisition, and not unfrequently a cheaper substitute is that of chasing, which is much more quickly done, and consequently costs less. As engraving or chasing forms a very important item in the cost of an article, various means have been devised from time to time to take its place—among others, that of etching. The objection to this method, however, is the undeniable want of finish in the lines or surfaces operated upon by the acid, and their presenting a rough appearance as a necessary condition contingent upon the effect of the acid. The process is practised as follows:—From engraved plates or other surfaces, impressions on tissue paper are taken in varnish-ink; the surface of the metal to be ornamented is cleansed, so as to be quite free from grease; and the tissue paper with the design is then transferred to the surface of the metal, in the same manner as is employed in the pottery trade when a design is put upon the ware in its biscuit state. The impression is thus transferred to the metal, the tissue paper being removed by washing it off; a coating of gum is next applied to protect the surface which it is not desired to etch; a little turpentine applied to the transfer dissolves the varnish-ink of the impression, and leaves the lines exposed to the action of the acid to which the article is to be subjected. This being done, a copy of the original design will be found bitten in on the surface of the object which it is desired to ornament, the coating or protecting ground is thereafter removed, and the article finished by the ordinary method. When the lines of a design are desired to be left in relief, this is done by simply reversing the process—viz., protecting the impression by dusting it over with powdered resin or asphalte, and subjecting the article on which the transfer has been made to a degree of heat sufficient to produce fusion of the particles of the resin; etching then follows, and the portion previously sunk will be found in relief on a dead ground.

Permit me now to direct your attention to a process which has recently been introduced, with what success the specimens displayed before you will enable you to judge. The merit and chief recommendation of the invention is its very great simplicity, the ease, speed, and facility with which the effect of a reticulated surface, an elaborated, chased, or an elegant scroll or floriated design, apparently engraved, may be introduced on any object. The fact of a soft material imprinting upon a harder one an impress of its form has long been understood; its practical application to the production of ornamental designs upon metal is, however, but of very recent origin. Ornamentation has been produced by rolls upon which the designs have been cut in relief, or the reverse, as those on copper cylindrical calico printing-rollers. The cost of sinking such rolls in steel is necessarily very expensive; as a new one would be needed for every change of ornament, their accumulation would become a very heavy drawback on the capital of the manufacturer. By the present process the cost is much diminished, leaving ample room for the introduction from time to time of new and superior designs to meet the taste or requirements of the market. The practical application of the process is due to Mr. R. T. Sturges, of Birmingham, who, in connection with Mr. R. W. Winfield, of Birmingham, is a proprietor of the patent. The origin of the invention may be traced to the competitive spirit of trade, which operates with so much effect upon the manufacturing industry of our country, calling into action the inventive faculty to devise new and more economic methods of effecting certain results. The idea once originated, it is singular to trace its gradual development. In its early stage, it was imagined that the harder the material out of which the pattern or design was made the better for the purpose. Keeping this then-imagined requisite in view, the first ornament imprinted was made out of steel-wire formed into shape, and thereafter tempered; designs of a more complicated and minute character it was expected could be produced by using metallic lace or wire-web. I may here remark, that this idea gave the hint which resulted in the production of the wire-lace exhibited by Mr. Carey, of Nottingham, in your recent exhibition of patented inventions. This may be cited as a forcible illustration of the effect one invention may have in stimulating or introducing a new feature into a manufacture of an entirely different kind from that in which the want originated. I now exhibit to you the result produced from a piece of crochet-work in wire; it is remarkably indefinite and unsatisfactory, as the metallic wire cannot be drawn up tight into shape, owing to the elasticity of the wire out of which the design is made. The loops being loose, the consequence of the pressure to which the plates of metal are subjected, in order to receive the ornamental device, cause distortion or flattening, which completely destroys the arrangement of the threads or wires.

This led to the somewhat singular idea, that in all probability ordinary thread-lace could be used for the purpose of producing a device upon softer metals. I may here state, that the result of this experiment was just another illustration of the saying of Sir John Herschel, illustrative of the difference between theory and practice; thus no mere philosopher in his study could have predicted that so tender and fragile a fabric as ordinary thread-lace would have sustained a pressure of not less than ten tons, and come out from such a pressure comparatively uninjured, leaving its impress even on so soft a substance as Britannia metal; but how much greater is our wonder increased when we find the same result is produced on copper, and on the harder metal, formed by its alloy with zinc—namely, brass—the yet harder German silver, iron, or tin-plate, and more wonderful still on what we are led to believe is the most dense and hardest metal in ordinary use—viz., steel. I now exhibit to you the first experiment made with thread-lace, which is interesting, as demonstrating a very peculiar fact, and affords a very excellent illustration of a great philosophical truth—viz., the indestructibility of matter; it was found, as will be anticipated, that the more perfect and closely twisted the thread of which the lace is made the better and more definite is the impression. The transition from rags to paper is a natural one, and patterns or designs formed out of perforated paper were next tried. From its density, the almost complete cohesion of its fibres, and their close proximity to each other, it was found on experiment that designs formed thereof produced very satisfactory results, while in point of economy it is even superior. As a curious illustration of its capability of resisting pressure, I may state that I have myself passed through metal rolls, without injury, the same piece of perforated paper (ordinary writing-paper) in the ornamentation of tin-plates not less than ten times, after which it was not entirely useless, but it became hard and brittle, owing to the cohesion of the particles being destroyed by the compression it had undergone.

By far the most useful practical application of the invention was yet in store; and in economy of its reproductive powers, it bears a near relation to the multiplication of the duplicate steel plates from which the Bank of England notes are printed, and which are produced by pressure, in the first instance, from one original engraved plate, or to the production of the plates from which our ordinary penny postage-stamps are printed, the original of which, up to 1852, had been only once engraved. The reproduction in the two instances last mentioned is effected by means of steel rollers, the periphery of which, by pressure on the original plate, has received an impression of the engraving in relief, and which when hardened impresses upon the surface of a soft steel-plate, a fac-simile of the original. The plan adopted in the present instance, and applied to the ornamentation of metal, is somewhat similar:—A steel-plate very equal in thickness is selected, on which the design requisite for the ornamentation of the salver, tray, or other object, is engraved in the ordinary manner, but somewhat deeper, the point of the graver employed to cut the lines being ground more acute. The engraving must be carefully executed; erasures or scrapings out, or beatings up of the plate from behind, must be avoided, as where they occur they are detrimental to the appearance and uniformity of the work. The least departure from perfect flatness of surface or equality of thickness is fatal to the perfection of the impression. From this plate a matrix or impression is taken in German silver, steel, or other metal, by passing the plate to be used as the matrix, and the engraved plate or design to be copied from, through a pair of rolls, observing however that the pressure of the rolls is uniform all over the surface, or, in technical language, that the "pinch" is equal. If this has been the case, and if the pressure applied has been sufficient, the result will be, that upon the previously blank sheet of metal an impression, with elevated or projecting portions corresponding to the sunk lines in the engraved or chased original plate will follow. This impression is then used as the medium from which to obtain the ornamental blank thereafter to be made up. This is done, as in the former instance, by placing the sheet of metal to be ornamented with its face to the plate with the raised or projecting portions, and passing them through the rolls as before; the consequence is, that every line of the original design will be found impressed or indented into the previously plain sheet or blank of metal. The original steel-plate is thus used only for the preparation of reverses, one of which, however, may be used many times in succession, or in proportion to the hardness of the metal to be ornamented. The blanks, after being ornamented, may be stamped or spun up into shape; if of a globular or regular form of outline, if irregular, hexagon, octagon, or with bosses, the metal out of which the vessel or article is formed is ornamented in separate portions, which are thereafter bent, stamped, or raised into shape, fitted and soldered together. After trimming and dressing, the plating or silvering is effected by the electro-deposit process; burnishing follows, the tools employed being burnishers made of blood-stone. Females are principally engaged in this portion of the work. As the two last processes mentioned are very generally understood, it is unnecessary to do more than simply allude to them. It may not be out of place, before concluding the notice of this method of producing surface ornamentation, to remark, that the excellence—or the reverse—of the ornamentation bears a correct proportion to the original steel-plate, and just in so far as the design is a good one, and the engraver of the steel-plate has executed his part well, will the result be satisfactory, or in the inverse ratio; it is, in fact, just as faithful a copy upon a sheet of metal, as an engraving by Wass or Finden is upon paper. It affords a ready and cheap method of introducing good ornament in the place of unmeaning, ungraceful, inelegant, and badly-executed hand-chasing or engraving, which in general serve to deface what they are intended to adorn.

I now desire to direct your attention for a brief period to a subject which within the last few weeks has attracted some notice; and though somewhat out of place in a paper proposing to treat upon the working and ornamentation of metals, yet, in so far as the means employed to impress on metal certain indentations which are to be printed from, there is no difference whatever. I here refer to the art of natural printing, for which the Austrians have preferred a claim, taking to themselves an amount of credit to which, with all due deference to them, I think they are scarcely entitled, even had the invention been one of greater magnitude, and capable of a much more extended application than it really is; the process is simply that of producing on a piece of lead an impression from a natural object, such as a flower, a leaf, a feather, &c. This is done by means of rolls, as already shown. From the lead impression they take a copy by the deposit process, the lines of which are in relief; from this, again, they take another copy, which is printed from. The earliest application of the principle in which metal was used by the Austrians, in order to copy *lace*, appears to have taken place somewhere between May and October 1852; but Mr. Sturges had in August 1851 printed the two specimens of needlework and net now exhibited. It is very important to remark, that the English patent for the ornamentation of metals was sealed on the 24th January 1852, while the patterns of lace which directed the attention of Auer to the subject, was received by them at Vienna in May of the same year. The patent of Worrung does not appear to have been taken out until the 12th October 1852, three months after the English patent was specified, and when all the details of the process were explained at length in the then published specification. In the month of December 1852, I happened to be making some experiments on the process for ornamenting metals. I used various media, impressions of which I printed from; they are now before you. Reasoning from these, I at once saw that media of even a more fragile kind than had previously been used might be impressed on metal; I therefore experimented upon decayed leaves, feathers, &c., with the most perfect success, and as I think by your examination of the specimens exhibited you will readily admit. As my time is much taken up, the range of subjects has been somewhat limited from which I have procured impressions: but these have not been produced at third hand, as has been the practice of the Austrians, Messrs. Bradbury and Evans, and, until very recently, of Dr. Branson of Sheffield. In every instance save those in which I printed from transfers on stone, taken from my Britannia metal plates, I have printed from the plate indented by the object copied. The copying from the lead by deposition, using the lead impression as a matrix, and from the plate so copied with raised lines to copy another with sunk lines, which is that used to print from, can only result in losing many of the minute touches which constitute and form the chief recommendations of natural printing. ***In printing direct I therefore stood alone.*** Dr. Branson in the 'Journal of the Society of Arts,' has announced that a "step in advance had been made," by ***his*** discovering that Britannia metal was a better material than lead to take an impression, and it could be printed from. ***I made the discovery fourteen months ago,*** and acted upon it. If Dr. Branson had read the ***Athenæum*** of the 10th December last, he would have found I made no secret of the material used by me. In like manner, as to the application of the transfer to the lithographic stone; this I had also done some time before Dr. Branson's letter appeared. I must, however, hazard an opinion, that when lines of an exceedingly delicate kind occur, as in the down of a feather, the stone will not print a great number of impressions clear, but will be apt to block. Where the markings are clear and distinct in the object copied, the result will be more successful, though a want of solidity in the lines (a defect inherent to transfer lithography) may be anticipated.

In conclusion, it remains for me but to thank you for the attention with which you have listened to the paper just read. In treating the subject, a purpose has been kept in view—viz., to try to explain the principles involved in certain methods employed for the production of ornament, and this in order to guide the industrial designer to sure and certain results. To be successful, the processes involved in the production of articles of manufacture must be understood, and to this the earnest attention of all interested in the improvement of manufacture should be directed. The abstract teaching of design is comparatively valueless, and success will only be achieved when to the taste of the designer the skill of the workman is united. Without ignoring the higher walks of industrial art, that which addresses itself to the great body of the people should be specially cared for. In industrial art, as in poetry, we must have that which adapts itself to the various tastes and conditions of men. If we have Dantes, Miltons, and Shakspeares to pourtray the sublimity and grandeur of the unseen world, or express the deep, subtle, and nice distinctions which mark the mental constitution of man, we must also have Goldsmiths, Bloomfields, and Clares, who have a humbler walk, but who not the less address themselves and give delight to a more extended circle of admirers. If in painting we have Turners, Hiltons, Maclises, and Ettys, we must also have Creswicks, Redgraves, Mulreadys, Websters, and Friths. Taking nature for our guide, we find associated together structures the most complex and simple. Under the shadow of the rose blooms the lowly daisy; near the lordly oak the hawthorn blows. Let us, then, take care of that art which is intended to penetrate into the houses of the lowly. In doing this, we may be assured, that that which is intended to embrace a more exalted position will not be forgotten.

*Discussion.*—In reply to questions from different members, Mr. AITKEN stated, that from the Britannia metal plate then being printed from, on which leaves of trees were represented, he had already had upwards of 170 impressions taken. These leaves were dried; he had never attempted to transfer any in a pulpy state.

Mr. H. COLE (the Chairman) said—Of course the simpler the process the more valuable it was; and it therefore could not be denied that the nature printing of Mr. Aitken had great advantages over a system which had to pass through two or three processes to produce the same result. He apprehended there would be no chemical difficulty in printing in colours; it was purely a mechanical process. There appeared to be one point of difference between Mr. Aitken and Dr. Branson. The latter gentleman, he believed, had taken impressions of plants in their pulpy state. One of the dried leaves which Mr. Aitken had made use of he now held in his hand, and, although it was finer than the finest lace, it had not been injured by being pressed between copper plates.

Mr. Aitken believed that Dr. Branson originally used gutta-percha; and, after getting a deposit, it was transferred to metal. Where these things had to undergo two or three processes, the lines did not come out so smooth, fair, or well-defined, as when they were at once impressed on the metal. He should say that there would be a great difficulty in obtaining an impression of a leaf or flower in its soft or pulpy state, in consequence of the hardness of the metal and the pressure to which it was subjected. He then produced a coffee-pot of tinned iron, ornamented by this process, the medium being perforated paper. In reply to questions from Mr. Taylor, Mr. Aitken said he did not believe the impression would soon wear off in ordinary use; indeed, he had heated tinned plates so treated and wiped off the tin, and found the impression still deeply indented into the iron. He introduced this style of ornament in tin manufacture about two years since. In Sheffield he had seen large salvers chased for 8d. each, the work being done by boys who had received no instruction whatever in drawing. By the process of pressure the manufacturer, by paying a fair sum for an engraving in the first instance, might turn out a really elegant and artistic article at less cost than that now paid for the inferior workmanship.

Mr. H. Cole believed there could be no doubt on the point, that engraving might be almost constantly reproduced by pressure. The postage-stamp was a proof of that. There were 240 heads on a sheet of these stamps, and he was afraid to say how many millions of these sheets of stamps had been printed. Yet all had been produced from one head originally engraved upon steel, which had been repeated 240 times over on a sheet by the agency of rolling, and from that sheet impressions on plates had since been taken. The application of the principle and the proof of its costlessness might therefore be dated from the introduction of postage-stamps, though it had been previously applied to the plates from which bank-notes were printed, as a means of getting exact uniformity in a difficult and intricate pattern, and thereby render the detection of forgery comparatively easy. The cost of the postage-stamps to the country was so infinitesimal as scarcely to be worth consideration in comparison with the amount they produced.

## CABINET MAKING.*

Among the subsidiary trades connected with internal architecture, those of the cabinet-maker and upholsterer are the most important. Upon their co-operation it depends whether the design of the architect—if design there be—be carried out or marred, for it too often happens that these workmen are not dependent on the instructions of the architect. If architects were wise in their generation, they would when called in by private employers, or in the case of clubs, libraries, and the like structures, propose that they should superintend the furniture and fittings. Some architects, it is true, think this beneath them, —so Barry has not thought at the Westminster Palace or Reform Club; some are too indolent or too ignorant to charge themselves with such detail; some fear it will not repay them to undertake it. If a man has truly laboured to produce an artistic composition and effect, and if he is studious of his reputation, he will certainly not run the risk of having his labours frustrated by ignorant successors. Of course it will be said that employers or their ladies have their own notions, or as they call it, taste, as to furnishing; but we believe there are few cases where there would be any obstacle from such quarters if the architect took the trouble of entering into explanations on the subject. Those who have indulged their own taste are commonly very much annoyed when the consequences, in the shape of monstrous blunders, are pointed out to them; and the visitors to the cabinet of monstrosities at the Museum of Practical Art, have experienced such horror at seeing their favourite subjects in the *index expurgatorius* of that establishment, that they would willingly in the case of new experiments avail themselves of competent professional advice.

While there are such motives for the action of professional men, we believe there are some obstacles, for there are many not wanting in abilities or in knowledge of the higher branches of their art, who not having studied these matters of detail are incompetent for their treatment, and who, if intrusted with such a responsibility, offer such crude suggestions and tasteless designs, that their employers are not tempted again to incur the expense of demanding their services. Then again there are other members possessed of more taste, who make propositions so at variance with practical requirements and utility, for the mere purposes of display, that utilitarian householders refuse their concurrence. In this department utility is so essentially connected with art, that the two requirements are hardly to be dissevered, or if a preference be given, it must be to the former; and hence, to a well informed man, there is a particular gratification in the achievement of such results as may satisfy the eye and yet be found to minister usefully for the special purposes for which designed. Hence, on the other hand, a workman with less knowledge of art, but knowing better what is practically available, is often allowed full sway, to the detriment of what has already been done, and perhaps to the complete disfigurement of a well-balanced design, on which great expense has been incurred.

Why the labours of the architect should by any be held to end with the walls we cannot imagine, or why the upholsterer or cabinet-maker and their brother workmen should be let in to exercise independent functions, where they are naturally only ministers to the architect. Thus the architect designs the chimney, and the ironmonger is allowed to put in a stove utterly incongruous; the architect arranges his openings with due effect for the doors and windows, when the upholsterer comes and with curtains alters the effect of the windows, and puts in glasses which overbalance the arrangement of the doors or chimney piers. Then there is the paperhanger, who likewise operates on his own account, and who has a favourite contrivance in the arrangement of panels with borders, in virtue of which the doors, chimney, and windows come under such a form that it is made to appear as if the unfortunate architect had originally forgotten the means of access and lighting for the room, and that after the upholsterer had decorated it the architect had wilfully cut openings in his panels and ornaments for the requisite doors and windows. The gas-fitter sticks up a mediæval chandelier to match a Greek or Roman cornice; and the carpet planner declares war against the paperhanger, and lays down a totally opposed botanical or zoological illustration in an incompatible colour key. We have seen the ceiling, the papering, and the carpeting, each on independent and dissociative principles, with furniture and hangings, glasses, ironmongery, and gasfittings affording other incompatible members of the strange political community. The happy family in the cage at Trafalgar Square is nothing in comparison with some of the neighbouring mansions, where dissonant elements are congregated in far greater profusion and variety.

Upon what ground the upholsterer, the cabinet-maker, and the rest of the operators should be indulged in an independent career, it is difficult to understand, for unfortunately their artistic proficiency is neither attested by their education nor their works. We can very well understand an employer suggesting to an architect that he wishes an arrangement compatible with certain furniture already in his possession, or to accommodate some particular object; but it is not easy to see why the workman is to be allowed to carry on a virtual rebellion against the architect. The latter is the responsible artistic adviser, and the sooner he assumes this responsibility the better for all parties. The workman himself will profit by it, for his co-operation with the architect will train him in the combination of his works with a larger composition, insuring unity of design. The architect will benefit, because having an assurance that his ideas will receive due completion, and having before him the means of obtaining a better effect, he will be induced to study more carefully the means of obtaining interior effects. It need hardly be said that the employer and the public will obtain the full advantage from such co-operation.

If the architect finds it necessary to undertake such responsibility in his larger works, the same principle must urge him to a like charge in smaller works. Where this has been done very pleasing results have been achieved, and our exhibitions show some admirable interiors; but it has been well pointed out by "Candidus" and other writers in this *Journal*, that the variety of effects to be obtained by interior arrangements have been too little regarded. If the architect plans out certain rooms he commonly thinks he has done enough; he provides four walls, a

* 'The Cabinetmaker's Assistant: a series of Original Designs for Modern Furniture, with Descriptions and Details of Construction. Preceded by Practical Observations on the Materials and Manufacture of Cabinet-work, and Instructions in Drawing adapted to the Trade.' Blackie and Son, Glasgow and London. 1853.

ceiling, and a floor, and there his labours end: yet should he be fortunate enough to have the direction of a senate hall, of a club, or of a public library, he will not let a workman meddle with anything, but carefully prepares a design for every ornament and fitting. The recent arrangements as to churches have imposed a like care. Ecclesiological critics are exacting enough, and even to a chandelier or a free-seat there must be provided competent designs, preserving congruity of style and arrangement. The large class of works provided by the progress of church extension has given a valuable lesson in this respect, and has afforded good opportunities for training. What is wanted is to carry out the same system in domestic architecture, for what can be done for a palace or a club can be done as effectively for a villa, if not as sumptuously, and by the spread of sound principles would in time be provided for the cottage. The effect of a clubhouse arrangement, for instance, is very much enchanced by those judicious designs which have produced scenic interiors by the proper disposition of every detail.

The progress of the arts of design has been, there is reason to consider, materially impeded by the want of this salutary control on the part of the architect, for though certain conventional niches are sometimes provided, they are never filled with statuary, and panelling is not supplied with pictures, because the architect walks out with the plasterer, and the upholsterer prefers his own art to that of the sculptor and painter. The architect, on the contrary, prefers the co-operation of the two latter to that of the artistic workman, whose labours he adopts in subordination.

The work now before us takes up the subject in a proper spirit, and is calculated to produce a very beneficial effect on the trade to which it is addressed; and its greatest merit is, that it is a special work for a special trade, but none the less valuable to the architect, because it is a thoroughly practical work. The author writes for cabinet-makers, and he proceeds on the principle that it is much better to explain fully, and to be thought commonplace or trivial, than, by presuming too much on the previous knowledge of the reader, neglecting anything essential for information. For the workman, the course of practical geometry and mathematical drawing introduced will be very useful, because this is precisely what is essential for him to know, and precisely what is neglected. The author has not lost sight of the fact, that notwithstanding the progress we have of late years made, the majority of our workmen bestow far too little thought upon the articles they manufacture, whether as respects the materials of which they are constructed, the way in which they are made, the ends they are to serve, or the designs after which they are fashioned. Hence he observes, that many good plans are copied and re-copied by the unthinking many, without any intelligent appreciation, and, as a necessary consequence, the articles thus unintelligently copied have a constant tendency to degenerate in character in the hands of the copyist. He might even have added, that where an improvement is introduced it is rendered worthless, being wrongly applied.

It is well observed, that one of the leading causes of this state of things is doubtless the imperfect training given to apprentices, who when told what to do, are not properly shown how to do it, or the reason for doing it. He becomes a mere mechanical workman, even where a good one; and his reasoning faculties having been left dormant by his master, he seldom attains any particular eminence in his trade, and instead of an originator, becomes an inferior copyist. If, indeed, he should have the curiosity to inquire the why and wherefore, he is often thwarted by his master, it being a common practice in many branches of this trade to keep back instruction from the apprentices. In the metropolis, which is a great seat of the cabinet trades, employing many thousand hands, much is done by what are called chamber-masters, or in other places room-masters,—men working in a single room with an apprentice or two, or may be a journeyman, and jealous of the apprentice becoming a master and a competitor; for the amount of capital required for an outfit is so small, that in the special branches every apprentice looks forward to setting up as a master. This, which should be the element of good, is in many respects that of evil: the training of the apprentice is thwarted in the way we have stated, and the education of apprentice or master in design is neglected. The number of masters is, however, checked by various operations; for though in prosperous times and with high wages, many journeymen get the means to start as masters, yet their small capital becomes exhausted by their competition, by unfavourable bargains in wood, by long credit with the middlemen, and by bad debts. The existence of the chamber-masters in numbers favours the operations of a large number of middlemen, who keep the larger establishments, finish or put together the work, and supply the dealers, or themselves become dealers. Many of these work on the capital of the chamber-masters, from whom they receive long credits according to the extent of competition. These middlemen are in the habit of giving out designs in mass, which are reproduced by wholesale, and save the inferior chamber-masters from the necessity of designing. Some of the chamber-masters however, who are better instructed, submit their own designs to the middlemen, obtaining orders on the strength of the novelty or variety of such designs.

Another cause of the backward state of our workmen has been the want of schools of design, and of elementary instruction in drawing and modelling in the common schools, and this is a want which is being very slowly remedied. The author dwells on the advantages that the foreign workman has in the means of cultivating his taste, and he might have enforced this by the practical results, for although Australia has given a great impulse to our export trade, yet France, and more particularly Belgium, have a share in the export cabinet trade far beyond what their commercial position would naturally authorise them to obtain, and of course this is so much subtracted from the funds for the employment of our workmen, now devoted to the training of rivals. It is observed, with too great truth, that the workmen generally have not availed themselves to the extent they might have done of the means of instruction actually within their reach. Mechanics' institutes, schools of arts, &c., have during the last thirty years risen and multiplied in all our great towns, yet how small a portion of the young mechanics have taken advantage of them to acquire that knowledge of mathematics, natural philosophy, and kindred branches of study, that might through their means have been obtained. We regret, too, that the working classes have not derived all the advantage they might have done, and that the chief benefits have accrued to the more intelligent young men of the middle classes; but we believe that instruction has been much checked by the system of payment. It is the doctrine of the middle classes, that as money is the only thing to be valued, so education is only to be measured by a money price, and will not be valued unless it is paid for. This, however, is not the sentiment with the working classes, nor is it with the poorer students of the middle classes. In what are called the dark ages, a better spirit prevailed, and the poor scholar who had risen to wealth and dignity, remembering his early struggles, founded, for gratuitous instruction for the *pauperos et egentes*, those noble foundations now converted into sinecures for a few favoured churchmen and fellows. A very serious reflection on this great metropolis, notwithstanding the many benevolent and useful establishments we possess, is the paucity of institutions for gratuitous instruction. In attempting to compete successfully with our foreign rivals, we must have corresponding advantages, for the mere establishment of a few schools of design is not enough. We must have schools and institutions of the same character, and gratuitous admission. This we require on various grounds; among others, because the working classes, not being aware of the full value of instruction in design, need to be invited, and not repelled; and secondly, because many of the apprentices—hundreds and thousands, perhaps, in this metropolis — cannot afford to pay the moderate fees required for instruction, or must do so by the sacrifice of other objects. A little better acquaintance with the working classes would show at how hard a price is instruction obtained by the zealous learner. There are the fees for the school of design and the mechanics' institute, but the expense does not end there—there are books and materials. These expenses perhaps absorb those small savings meant as the reserve in sickness or dearth of employment. The working man, too, has his benefit society to pay, and has demands on his private charity, claims for a fellow workman in distress, for members of his family, and for trade purposes. Besides the money contribution, he must make a considerable self-sacrifice of time and disposition after a hard day's toil. The public benefit to be derived from the instruction of our workmen is perhaps greater than that of the individual, and at any rate it will answer public purposes to provide the moderate funds required.

A section of the work before us, which will be found very useful to cabinet-makers, is that on the selection of cabinet woods —a very difficult subject, one of great importance to the small master, and which is treated very minutely and very carefully. It is by no means uncommon for the cabinet-maker to pay a considerable sum for a log which turns out utterly worthless. The following remarks on Rosewood will illustrate this:—

"In selecting rosewood for purchase, it is of importance to attend to the size, soundness, colour, and figure, of the planks of which the various lots are composed. Planks of a small size, although bought at a lower price than larger wood, will be found less profitable to the cabinet-maker. For the manufacturer of picture frames, or of brushes, the narrow breadth is less objectionable; but in purchasing it as a material for furniture, the full-sized wood, although it cost more money, will be found the most economical. It is a matter of greater difficulty, in general, to secure *sound* wood, than to get it of a proper size; since, in importations of a fine quality, it is not uncommon to find the greater proportion of the planks, or half logs, scooped out on the heart side as if designed for pumps or canoes; and this may be the case to a considerable extent, even although it does not appear at the the ends of the wood. Pieces that are marked by sudden bends lengthways, are to be avoided as suspicious, where there is no opportunity to turn over and examine them. But the *colour* is of more importance than either size or soundness in rosewood. Much of it is to be found of a dull light brown colour, resembling nothing more than a dried peat; whereas in wood of good quality, the ground is of a clear sharp colour, varying in depth of shade from orange to dark red, having the graining or figure distinctly marked in black. In seeking to ascertain the colour, it is desirable to learn what it is near the heart; for often a thin rind of good coloured wood is found on the outside, enclosing a very inferior heart. The value, of course, is greatly increased when the wood is well coloured throughout. In seeking for wood of a fine figure, special attention is to be paid to the appearance of the annular rings, as seen in the ends of the planks. When the concentric circles of red and black are found regular, or only slightly irregular, much show or figure is not to be expected. But when, on the contrary, they are found in waving and tortuous lines, a good figure is certain to be found. Another indication of fine figure is the plank being marked by knobby protuberances, which, when pierced, are found of a light colour. These, when intersected by the straight line of the veneer saw, produce an abrupt dash of light, which contrasts very agreeably with the sober aspect of the general surface; and, therefore, planks having these knobs, and other indications of figure, should be carefully selected for veneers, while the plainer pieces are reserved for chair wood, couch-feet and scrolls, table-pillars and claws, and solid work generally. In cutting up veneer planks, regard must be had to the form of the concentric circles, in order to bring out the best figure which the plank is capable of exhibiting; and this object will be best secured by making the saw-draughts run as nearly as possible parallel to the circles.

"In drying rosewood, it is of importance to take care that it is neither exposed unsheltered to the rays of the sun, nor suddenly to artificial heat; for either will have the effect of producing cracks, which, even although they close, cannot be concealed in the finished work. To make good furniture of this wood it is especially necessary that it be gradually and thoroughly seasoned; otherwise it is sure to betray the neglect afterwards.

"Another peculiarity of rosewood is, that much of it is very porous, and that the pores are elongated on the surface, in a way that renders it difficult to produce a good solid body of polish on it. To remedy this, various plans have been tried. Size of various kinds has been employed to fill in the pores: but although well papered off, it furnishes a very harsh and ungenial surface to polish upon, and shrinks below the surface afterwards. Blackened bees'-wax has been rubbed in, and then cleaned off; but this has the effect of preventing the polish from getting properly riveted in the wood, and causes it, when the article is in use, to peel off on the least friction. The best remedy yet discovered, is, after the surface has been finished by the cabinet-maker, to rub it carefully in with plaster of Paris, coloured with rose-pink, which, after being *set*, is to be carefully papered off. This does not shrink like the size; and has the effect of preventing the oil used with the French polish from finding a hiding-place in the pores, whence it afterwards exudes on exposure to the air, and eats off the polish like rust on a metallic surface. The dull brown colour of a large portion of rosewood, has led to a variety of experiments to improve its appearance. Some have tried the dyeing of it with successive coatings of an infusion of logwood, but the effect is so unsatisfactory as not to repay the trouble. Others have used a strong solution of gum-dragon, or dragon's-blood, as it is commonly termed. This produces a very enlivening effect, in superinducing a rich purple hue on the dull brown of the wood; but it always presents the appearance of a thick coloured or painted medium being interposed between the spectator and the wood. We think it decidedly preferable to make use of a vegetable colouring, such as the extract of camwood, or other dyewood of the required tint; which, in solution with spirits of wine, produces the desired change on the colour of the wood, without suggesting the idea of its being painted."

The designs given for each description of furniture are very numerous, and very carefully described in the text. The work is a very useful one, and will we hope be successful.

## AUSTRALIAN AND COLONIAL RAILWAYS.

In consequence of the state of communication in Australia, South Africa, India, and our other possessions, I have submitted a plan, which has received the sanction of many of the home and colonial authorities, members of the legislature and capitalists, and which is now under consideration in Australia. The progress of Australia, it is felt, demands a large extent of railway communication. Such communication is there the more important, because the districts to be connected are far apart and the population scattered. In England a railway is considered necessary for a dense population,—in America for a thinly inhabited district, and as an instrument of colonisation and local improvement. Hence, no sooner does a Western State acquire the necessary organisation, than immediate steps are taken to form a railway system under circumstances far less favourable than those of Australia at the present moment. Nothing has indeed contributed more than these endeavours to the progress of the Western States, and the establishment of that vast population beyond the Mississippi; and there is nothing to prevent the like measures in Australia from being attended with equal success, the more particularly as there is no great inland navigation.

The want of railways has long been felt in Australia, and the cause has been ably advocated by her legislators, but hitherto no great undertaking has been effected. Through the liberality of the legislature of New South Wales, a short railway from Sydney to Goulburn is in progress under a liberal guarantee; the legislature of Victoria has made similar exertions for three other short railways, and South Australia has authorised two short lines. The main objects, however, remain to be accomplished, and of these the chief and first is a trunk line, connecting Sydney or Goulburn with Melbourne.

The length will be under 600 miles, and the cost per mile, if constructed upon the American system, will not exceed 5000*l*. a mile. It is believed that the necessary labour can be obtained at the same rates and in the same manner as in Canada and the United States. Chinese labour has been proposed, but there is some difference of opinion among the members of the legislature on this subject.

To establish such a trunk line the concurrence of several favourable circumstances is necessary,—the co-operation of capitalists, satisfactory financial arrangements, but, above all, the necessary legislative facilities. For an undertaking so large there are two modes in which the legislature can afford assistance. The one is by guarantee of interests or dividend, as done by the legislature of Canada, and as already carried into effect by the legislatures of New South Wales and Victoria. The other is by grants of land on the proposed line of route, a course sanctioned by Her Majesty's government in the American provinces, and successfully adopted in Illinois.

With regard to a guarantee, doubt is felt by members of the legislature of New South Wales whether it would be justifiable to enter into further guarantees burthening the finances of the province, the more particularly for such a length of railway as that of the trunk line in that province. With regard to a grant of land, most of the land on the proposed route is already appropriated within the province of Victoria. It appeared therefore most suitable that an application should be made for a guarantee to the province of Victoria, and for a grant of land to the province of New South Wales. For this latter purpose not only is the concurrence of the local legislature necessary, but likewise it is anticipated the authority of the imperial parliament to give the necessary power under the Land Sales Act.

With a view to promote the execution of such a plan, and to obtain the concurrence of the legislature and administrative authorities, a committee of co-operation was formed, in which the Australian interests are represented.

The appropriation of land, which it is to be hoped will be obtained on such a basis, would be one section or more on each alternate mile of railway. In Illinois six square miles per mile run is granted; for the trunk line of the American provinces ten square miles. The effect of such appropriation will be readily seen. It imposes no actual outlay on the provincial legislatures; and although it involves the free grant of a large tract of land, it is remunerative to the provinces, and in no way a diminution of their resources. The provinces, holding the waste lands within their bounds, are interested in every measure for their improvement; and it is almost needless to say, that of all means of improvement a railway is most efficient. By giving every second section to a railway company, the other sections on the line are necessarily enhanced in value to more than the amount alienated, besides the increased value given to all the neighbouring allotments. Thus the legislatures, like those of America, have every interest in making such grants and in promoting railway extension.

So far as capitalists and shareholders are concerned, such appropriation is most beneficial. On each mile of railway the minimum appropriation amounts to one mile square, or 640 acres. This taken at the upset price of 1*l.* per acre would be a considerable bonus on a possible outlay of 3000*l.* per mile, but the very construction of the railway immediately affects the value of the land. Taking the available land of the free grants at 600 acres per square mile, the following would be the value at the several rates stated below, and which would yield a minimum of 3000*l.* per mile run upon the one section only.

| Estimated Ultimate Value. | One Section per Mile Run. | Two Sections per Mile Run. | Five Sections per Mile Run. |
|---|---|---|---|
| £5 per acre | £3,000 | £6,000 | £15,000 |
| 10 ,, | 6,000 | 12,000 | 30,000 |
| 20 ,, | 12,000 | 24,000 | 60,000 |

Of course for South Africa these prices would be different; but still by this system the most effective basis would be offered for railway construction, giving extensive employment to our engineers and machinists.

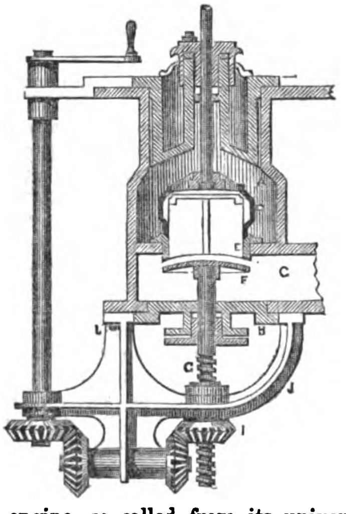
To those of your readers who may be interested in the promotion of railways in the colonies, I shall be happy to give every information and to receive their co-operation.

*Australian Rooms*, 189, *Strand*. Hyde Clark.
*March 25th*, 1854.

## SUPPLEMENTARY VALVE FOR CORNISH ENGINES.

— Birkinbine, *Patentee*, Philadelphia, U.S.*

The accompanying engraving shows a supplementary valve apparatus for Cornish engines, for which a patent was granted to Mr. Birkinbine in November last. The invention, though simple in itself, is likely to prove of considerable importance in connection with a class of steam-engines the merits of which have as yet been scarcely appreciated in this country, but which are now beginning to attract the attention of engineers, and will, without doubt, be eventually adopted in preference to all other hydraulic machinery for mining purposes, waterworks, &c.




The Cornish engine, so called from its universal adoption in the mining district of Cornwall, England, is single acting, the pressure of the steam acting on one side of the piston only, thereby raising the plunger and any requisite additional weights. The steam thus used in raising the plunger is afterwards admitted to the opposite side of the piston, and thus equalising the pressure on both sides, the weighted plunger descends and forces the water to the required height, completing one stroke of the engine. The steam contained in the cylinder is on the commencing of another lift of the plunger carried off through the exhaust-pipe to the condenser.

The several evolutions of the engine are effected by four valves; first, the regulator, through which is admitted the steam in the first instance, and whose movements are regulated by hand only; secondly, the steam-valve which admits steam to the cylinder; thirdly, the equilibrium-valve, by means of which the pressure on both sides of the piston is balanced; and, fourthly, the exhaust-valve through which the steam is carried off to the condenser. These valves are actuated by tappets on a plug-rod, which move simultaneously with the piston in conjunction with weighted levers, and the ingenious and well known cataract motion, the tappets serving to close, and the weighted levers (whose action is dependant on the cataract) to open the several valves. These are contained each in separate compartments of a chest or nozzle, communicating with each other and with the cylinder.

The required volume of steam is, in the first instance, admitted through the regulator-valve into the compartment occupied by the steam-valve, on the opening of which, by a weighted lever released by the cataract, the steam is admitted to the cylinder, thereby raising the plunger to the required height. In another compartment, which communicates with the passage through which the steam was admitted to the cylinder, is situated the equilibrium-valve, on the raising of which, the steam in the cylinder which has performed its duty of raising the plunger, passes into the space C, and thence through a pipe or passage to the opposite side of the piston, thus allowing the plunger to descend. The space C, communicates with the chamber of the exhaust-valve, as well as with the equilibrium passage; the exhaust-valve is, however, closed as long as the equilibrium-valve is open, and is not again brought into action until the engine is prepared to commence a new stroke. The accompanying sketch represents a sectional view of that portion of the valve-nozzle only which contains the equilibrium-valve, which will no doubt be sufficient, with the foregoing brief explanation, to render the apparatus familiar to our readers.

It may be here remarked that all the valves are of the double-beat description, so called from having two conical or beating surfaces instead of only one, as in the ordinary stalk-valve, and are in principle similar to those used in stationary and marine engines, and denominated balance-valves. D, is the equilibrium-valve contained in the compartment A, which communicates with the passage from the steam-valve to the cylinder. The seat of the valve D, is secured to the bottom of the compartment, and has a circular flange E, projecting through the opening. This projecting flange forms the seat for the supplementary-valve F, which is attached to the top of the screwed spindle G; the latter passes through a stuffing-box in the cover H, and screws into the hub of the bevel-wheel I, which runs loosely in the bracket J; this wheel is caused to revolve, and thus the supplementary-valve raised or lowered by the handle K, and shaft L, and the additional bevel-wheels.

The object of the invention is to arrest, more or less, as circumstances require, the passage of the steam through the equilibrium-valve from one side of the piston to the other, and, consequently, of regulating the descent of the plunger. The utility of the arrangement will be at once apparent: it obviates the necessity of adopting the old and tedious process of adding and removing heavy weights, while, in case of any breakage, or other accident occuring to the pumps in a mine, the damage likely to occur from sudden shocks is prevented by the facility of adjusting the valve to regulate the descent of the plungers.

It is in Cornish engines, when used for waterworks, however, where the utility of this invention may be brought into practice most advantageously, especially in those works where a stand-pipe is used to obtain the necessary head of water; in this case the fluctuation in the level of water is necessarily sudden, and of considerable extent, causing a similar variation of load on the engines, and rendering the machinery most unsafe and uncertain in its action. Should the head of water in the stand-pipe be low, the plunger would have a tendency to descend with a dangerous rapidity, which is checked in a moment by turning the handle K, so as to raise the supplementary-valve F, thereby arresting the steam on its passage from one side of the piston to the other, the plunger consequently descending with a safe and gradual motion. Should the head of water, on the contrary, be high, the valve F, is instantly withdrawn from the seat, and a free passage given to the steam, the head of water being in itself sufficient to ensure an easy descent of the plunger.

* From the 'Journal of the Franklin Institute.'

Although the apparatus is shown in the sketch as regulated by hand, it is proposed in some instances to allow the variations in the head of the head of water to be the means of adjustment, an application which might be made by a simple arrangement of machinery. It is Mr. Birkinbine's intention to apply his supplementary valve to the large engines he is now erecting for the West Philadelphia Water Works.

## RAILROAD SWITCH POINTER.

John Maston, *Inventor*, Saratoga, N.Y.*

The importance of a switch pointer which will show the engine driver at a glance, and without chance of mistake, whether the switch at any junction is in its proper position, is so great, that many forms of it have been invented, none of which have yet given perfect satisfaction, being either too clumsy, too complicated, or liable to be mistaken in their positions. The ordinary ball attached to the upper end of the long lever, indicates the position of the switch only by the inclination of the lever from or towards the line of rails; consequently, in dark and misty weather, the lever, which is generally thin and black, cannot be seen, and the position of the ball of itself indicates nothing. The vertical switch pointer, which shifts the rails by a crank at the lower end, and changes the vane at the top *across* the line of rails, or *parallel* with them, while it possesses great compactness and simplicity, has the defect, that when the switch is set for the main track, the *edge* of the vane is towards the engine driver, presenting the same appearance as if the vane were broken off altogether—an accident, by the way, which not unfrequently happens. On this switch also it is difficult to arrange lights for night signals.

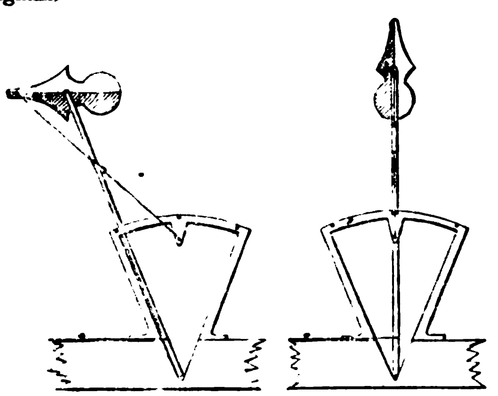


Fig. 1. Fig. 2.

The switch to be described, invented by Mr. John Maston, of the Repair Shops, Saratoga, N.Y., is intended to obviate these difficulties, and to indicate always unmistakeably for which line of rail the switch is set. The arrangement will be easily understood by reference to the annexed engraving. The dimensions are given for a particular case, and can be varied to suit circumstances. The long lever of the pointer moves about a pin through its lower end, and at a distance of 1 ft. 1 in. from this pin is jointed the horizontal bar which shifts the rails, which in this case switch through 4¾ inches. The entire length of the long lever from the bottom pin to the centre on which the vane is hung, is 6 ft. 6 in. The lever moves between the jaws of an arc 2 ft. 6 in. from the ground, in the upper edge of which notches are made, and a spring bolt on the lever retains it in its place when set for either track—a lock can very conveniently be applied to this bolt. The vane is of cast-iron, about 1 ft. 10 in. in length, and hung upon the upper end of the lever by a pin passing through it near its centre of gravity, the round end of the vane slightly preponderating. On a lug projecting downward from the arc, a rod is jointed at a distance of 2 ft. 9¾ in. vertically above the lower end of the lever; the other end of this rod, which is 4 ft. 8 in. long, being attached to a pin in the centre line of the vane, near the *point* 11½ inches from its point of suspension. This rod is forked where it crosses the lever, as represented in the drawing, embracing a pin in the lever, to make the reversing action more steady.

* From the 'Journal of the Franklin Institute.'

When the switch is set for the main track, the rod and lever, by their relative proportions, keep the vane in a vertical position, pointing directly upwards, as shown in fig. 2, showing the *whole flat side* of the vane to the engine driver, instead of the *edge*. Then, when the bars are shifted on to a siding, the lever moves over towards the siding, and the vane is turned by the action of the rod through a quarter of a revolution, pointing towards the track for which the switch is set, as in fig. 1.

It is obvious, that if the switch is for three tracks, when turned to the other side, the vane will point in the right direction for the third track. The vane is represented in the cut as painted half red, and half white, so as to be distinguished against any background. The proportions given, can of course be modified to suit particular cases. If the sinking of the lower end of the lever below the ground should be thought objectionable, it can be raised, and the switch rod bent down to the rails, or it may be made a lever of the first order, in which case the arrangement of the shifting rod must be altered.

Its advantages appear to be principally, great distinctness, the position of the vane being so decided as not to be possibly mistaken, and being not an arbitrary signal, but one easily understood, the vane actually pointing towards the track for which the switch is set. At night, different coloured lights being hung at the two extremities of the vane, their relative positions will indicate as well as the vane itself. In case the vane and its connections are out of order, so as not to indicate the change of track, the rod will prevent the lever from moving freely; and thus attract the attention of the switch tender. It is not composed of any complicated pieces, requiring expensive patterns or very exact forging, and is very easily repaired. Most of the ordinary lever pointers could be altered to this plan.

The switch pointer has had the great advantage of the test of experience. It is not merely a model, but has been in constant use about the stations at Saratoga and Ballston, and on the main line, where it gives more satisfaction than any switch hitherto used. An objection which may probably be urged against it, is, that the rods may be easily bent; but in practice this does not appear to be the case; at any rate, they being of wrought-iron, can be set upon an anvil in a few minutes, if they become bent.

## AMERICAN PATENT LAW REPORT.

*Report of the Examiners of American Patents for the year* 1852 (Part I., *Arts and Manufactures*. Washington. 1853.

[Second Notice.]

These reports, which are furnished annually to the Commissioners of Patents by the six Examiners of the Patent Office, although, from their brevity, they afford but an imperfect epitome of American patents, are nevertheless useful as an indication of the progress of the inventive genius of that country. Mr. H. B. Renwick impresses upon the American legislature the necessity and value of a succinct and clear digest of every patent, to be accompanied with carefully prepared drawings, when necessary, in a manner similar to the 'Brevets d' Invention,' published by the French Patent Office. He also at the same time reprobates as useless and superfluous, the project of publishing a systematic report of American inventions from the commencement of the present century up to the present day, and recommends that it should commence from the date of the present American Patent Law, thereby avoiding much that is crude and valueless.

Although no striking novelty of principle has appeared in these reports, yet much that is valuable and useful may be extracted from them. We have given a few of the chief inventions for which American patents have been granted. Under the class of Metallurgy, under the superintendence of Mr. H. B. Renwick, the first noticeable patent relates to a novel form of Reverberating Furnace, which is designed to dispense with the labour of stirring and balling materials exposed to the action of the fire in these furnaces. The grate, fire-chamber, ash-pit, and fire-bridge are constructed of brick in the usual manner. The body of the furnace, the roof, and working bottom are omitted, and their place is supplied by a cylinder of cast-iron lined with fire-brick, and caused to revolve upon metallic rollers by means of a cog-wheel or belt. This cylinder has an area about equal to that of the ordinary working chamber, and is provided with a door or man-hole. The materials, broken pig for instance, are introduced through the door, which is then closed; motion is now given to the horizontal cylinder, and each portion of its periphery in turn becomes the bottom, while the contents are rolled or turned over and over, and as continually agitated and exposed to the flame, which passes through the cylinder on its way to the chimney, as if acted upon by the ordinary rabble.—Another Furnace, having a similar object, has its bottom formed of a circular cast-iron table, covered with brick, and revolves on a vertical axis under the ordinary fire-brick roof of the reverberating furnace. Through the ordinary working door projects into the furnace and over the revolving bottom a rabble, connected at its outer end to a slide actuated by machinery, which imparts to it a reciprocating motion. This slide runs upon a guide, whose angle to the side of the furnace may be changed by the operator, and the rabble be thus forced to stir over every portion of the working bottom.

A useful invention relative to "Foundry apparatus," applicable to small castings, or pipes of less than 3 inches diameter, consists in an improved machine for tempering the sand, which is afterwards sifted and deposited in measured quantities in a flask; parting sand is then applied in the proper locality, and a pattern is forced into the flask. The machine then removes the pattern and returns the flask. The interior of the flask is shaped in such manner that there shall be the greatest depths or thicknesses of sand in the direction of the greatest compression, caused by forcing in the pattern, thus securing an equally hard face over the whole moulded surface. The same patent includes an improved core spindle, consisting of a long iron bar, of the sectional form of a cross, covered with wire from end to end, which thus takes the form of a helix. This spindle is coated with loam, and serves as the nucleus of a core more pervious to the air, and less apt to blow than those ordinarily employed.

An improved method of lifting the ordinary Trip Hammer, whereby any different degree of blow within the range of the lifting cams can be readily attained, consists in causing the cam, instead of acting directly upon a lifting leg, to act upon the end of a lever embracing the leg, and vibrating in a vertical plane. This lever is provided with a toggle catch, which grasps the leg firmly when the lever is raised, but has no hold thereon when the lever is falling. The point to which this lever shall fall is regulated by a wedge. The cams in their revolution strike it sooner or later according to the distance it has been permitted to drop, and the instant that the lever commences to rise it clasps and holds the leg, forcing the hammer up a distance proportioned to its own ascent only.

An invention for ensuring an equally sound and hard face on the entire surface of Anvils consists in forming the body of the anvil with a cavity extending from its bottom nearly to its face, allowing of the introduction of a stream of cold water to the centre of the mass, which is therefore cooled as rapidly as its exterior, and the soft spot in the centre of the steel face is prevented.

A machine for Threading Wood Screws has its centre somewhat like the fusee of a watch, but the grooves are in three sections, parallel to its axis, and deeply notched or serrated so as to form a series of cutters, counterparts of the thread of the screw to be cut. This cutter has a swift revolution on its axis, and its periphery revolves in contact with a blank, properly supported and presented to it; the blank revolves in the same direction as the cutter, with a slight motion in the direction of the axis of the cutter, and presses against the periphery of the same, so as first to mark, then to deepen, and finally to finish its thread. This machine renders the manufacture of small screws as profitable as those of the medium size.

A machine for forming Nuts acts in the following manner:—A heated iron bar, about the width and thickness of the intended nut, is advanced over a die-box of the exact shape of the periphery of the nut to be made. A die then descends, severs a blank from the bar, and forces it into the die-box. This die is bored out precisely to the same size as the aperture required in the nut, and as it carries the blank along forces it, still enclosed in the box, against a cylindrical punch, which punches out the hole, carries the disc it severs, and enters into the aperture in the die. This die, with the nut now punched out, and upon the punch in front of it, still advances until it brings the nut in contact with the face of another die, which, like itself, fills the die-box, and commences to move in the same direction as the first die is travelling, but with a less velocity. The nut is therefore submitted to powerful pressure between these two dies while still on the punch, and all cracks incident to the cutting or punching of it are thoroughly welded up, while the exterior of the nut is forced so strongly into the moulded faces of the dies, that, when discharged from the machine, it is nearly equal in smoothness to a nut that has been planed.

A machine has been patented for making the Thimbles used in the Rigging of Vessels. These thimbles are metallic rings, whose outsides are grooved, and whose insides are convex to the same extent that the exterior is concave. The machine consists of two shafts having a common axis, and so arranged as to revolve at the same time and in the same direction, and to be caused to approach or recede from each other. The contiguous ends of these shafts are provided with forming discs of the requisite shape to form the interior of the thimble. The discs, when brought together, exactly fill the finished thimble. A hammer, whose face is an exact counterpart of one quarter of the outside of the thimble, is so arranged as to strike repeated blows upon a piece of heated iron laid upon the discs, which, in course of revolution, present new surfaces of the iron to the action of the hammer, until it is bent into the circular form requisite. The shafts are then separated by a lever, and the finished thimble drops between them.

An ingenious automatic machine has been patented for performing, on a large scale, the well-known metallurgic operation of spinning up from a flat disc in a lathe, cups, platters, copper kettles, or brass batteries, &c., usually shaped by repeated blows of a small hand-hammer. A burnisher, provided, if necessary, with a friction roller, is forced, by means of screws and guides acting in curved slots, to travel in close contact with the exterior of a revolving cast-iron conical mandril. The flat disc of metal is clamped upon the apex of this conical former, revolves with it, and is gradually formed into shape by the action of the burnisher, Several mandrils, each more nearly approaching the form of the finished article, are employed to complete the operation of bringing the metal gradually, and without straining, into its new shape. An invention relating to the making of wrought-iron nails consists in arranging in the interior of a revolving ring, a radial series of gripers or pincers, each of which grasps firmly a blank. This ring revolves on its own axis, having an intermittent rotatory motion always in the same direction, and the gripers between each rest of the ring each revolve through a quadrant on their own axis. Inside the ring, and having axes coincident with it, are two rings carrying each a corresponding set of dies, one for each blank. These dies are arranged at different distances from the axes of their respective rings, the greatest difference being the length of a finished nail; and those attached to each ring are divided into two complete series, the one of narrow face being forgers, and the other much wider acting as finishers. The radial distance of these dies from their common centre is so graduated that each in succession acts upon a portion of the blank nearer to the point, the head thereof being held in a griper. When the griper ring is stationary these series of dies approach each other, each die giving a blow to the blank presented to it. The last griper in the series then drops a finished nail, and the first is provided with a new blank. On the movement of the griper wheel or ring, each griper makes a partial revolution on its axis, and, while doing so, advances the distance between two dies, and presents its blank, turned on its axis, to the secondary pair of dies, which again approach, as does the whole series, and act on the nail nearer its point than before. These motions are continually repeated until the nail is completely forged.

Under the class of Steam and Gas Engines, many practical and ingenious inventions have been patented, amongst which may be mentioned an improvement in Float-Gauges. In this arrangement, a vertical chamber or tube of large bore, is connected by branch pipes to both the steam and water spaces of the boiler, at some distance above and below the usual water level. This tube or chamber is closed at top, and is firmly cemented at bottom, below the lower branch connection, to a glass tube extending far below the water level and closed at its lower end. The upper tube has within it a float, from which descends an index-rod into the glass attachment. This index, owing to the absence of circulation in the glass tube, is always moving in water comparatively clear, cool, and unchanging in its temperature, and exercising no tendency to corrode or deposit upon the glass, or to fracture the same through sudden changes of temperature; the index, therefore, is always visible and less liable to disruption than the ordinary glass guage. Several varieties of syphon guages have been patented, for indicating the level of water and pressure of steam in the boiler at any point above the same; these prove eminently useful when applied to marine boilers, as the indicator may be located in the spar deck or hurricane deck, or pilot's house of steamships, thus giving the officers or engineers a check upon the firemen or stokers, without the necessity of visiting the fire-room.

An ingenious apparatus, capable of producing almost infinitely varied movements and stoppages of the Valves of Engines, is worthy of notice. Upon an ordinary eccentric, but outside the collar, in the direction of the length of the shaft, are cut cog-teeth. To the collar is fitted a hollow eccentric rod, carrying a small shaft, whose axis is parallel to the small shaft. The former shaft is free to revolve, and carries a main cog-wheel in gear with the teeth on the eccentric. This shaft also supports an eccentric provided with a collar, and a rod which passes through the hollow main eccentric rod, and carries the hook which takes in the pin of the rock shaft arm. The first eccentric imparts its usual motion to its rod, and by means of the cogs causes the secondary shaft to revolve, which actuates its own eccentric and rod. This latter rod, therefore, gives off a compound or duplex motion, dependent upon the varying throws of the two eccentrics and their relative position at any given time. A change in the relative diameters of the two cog-wheels will modify the differential or additional motion of the two eccentrics, as communicated to the secondary eccentric rod, causing it to move as if actuated by a cam of any desired form, at the same time avoiding jars and strains.

In an improved Vertical Engine, the pillars supporting the cylinder above the bed-plate are so shaped and arranged as to constitute the air pumps and condenser, thus effecting a saving of space and imparting additional firmness to the engine. In the same engine, the cut-off slide of one cylinder is actuated by a connection from the slide-valve cup of the other cylinder, the valve chests being arranged back to back. A supplementary sliding valve is also added in the side of the valve itself, by means of which the engine can be worked with full steam throughout the stroke, without altering the expansion gear.

In an ingenious arrangement of the Marine Steam Engine, the piston rod takes hold of a cross-head lying in the plane passing through the crank, from the four ends of which depend straps, attached to and moving up and down a ring surrounding the cylinder. The motion of this ring is governed by guides, and it has surrounding it a second ring, connected by two pivots, lying in a vertical plane passing through the shaft. To points ninety degrees from these pivots, on the outer ring, are attached the two ends of a forked connecting rod; the uppermost end of this rod forms the stril end, which receives the brass encircling the crank pin. This rod, as it rises and falls, oscillates with its ring upon the pivots, and at each oscillation passes into the split cross-head formerly named. This engine therefore occupies no more room than the ordinary oscillating engine, and dispenses with the trunnion, so objectionable in that description of engine.

In the department of Navigation a new system of Screw propulsion was patented by a French inventor, the object of which was partially to avoid the resistance offered by screw propellers, incapable of being hoisted out of water, to the progress of the vessel when under sail only. The wings of this propeller are arranged in pairs, and of equal width only with the dead wood of the vessel. The first pair, if there be six wings, is attached to a hollow shaft, the second pair is fastened to another hollow shaft concentric with and inside the first shaft, and the third pair is secured to a solid shaft inside the second shaft. The shafts are fitted with gearing and clamps, or their equivalents, to provide for alterations in their angular distance with respect to each other, or to clamp them in any specified relative position. This gearing is situated within the vessel, and by means of it the various blades are spread around the whole periphery of a circle, so that each acts in turn and in the same position as in an ordinary propeller. When the propeller is no longer to be used, and sail employed, the blades, by means of the gearing, are revolved so as to fold the one behind the other, like the leaves of a shut fan, and the whole set turned in a line with the dead wood, so as to offer little or no resistance to the progress of the vessel. The engine drives the whole of the shafts without altering their relative angular position, which is maintained by apparatus independent of the engine.

By a provision of the act of 1836, it is required that every applicant for a chemical patent in America shall deposit in the hands of the Examiner "specimens of the ingredients, and of the composition of matter, sufficient in quantity for the purpose of experiment;" these specimens it is the duty of the Examiner to test, and according to the result of his experiments the patent applied for is granted or refused. But by that fatality which occasionally attends the proceedings of most governments, whilst the American legislature passed the above measure, it provided no laboratory, or apparatus, or tests to experiment with, in consequence of which great inconvenience has been occasioned to the patent office and injustice to the inventor and the public, many patents having been granted that would have been refused, and others rejected that should have been granted. It is to be hoped that the petition of L. D. Gale, the Chemical Examiner, for the amendment of these anomalies, may meet with the sanction of Congress, and that this important section of patent routine may no longer be a source of annoyance and injustice.

The Report furnishes an abstract of each of the 48 Chemical patents, and much important information may be derived therefrom. The class of Agriculture includes no less than 27 patents for harvesters and 26 for seed planters, and embraces many highly ingenious and useful implements of agriculture. Under the class of Mathematical, Philosophical, and Optical instruments, 81 patents have been granted, embracing electrical apparatus, telegraphs, batteries, time-pieces, numbering machines, and pneumatic gauges, amongst which may be noticed:—A geometrical measuring instrument for finding the centres of wheels or circles, constructed upon the well-known principle, that if two tangents be extended until they intersect each other, a straight line bisecting the angle between them will pass through the centre of the circle. The instrument consists of two moveable arms united at one end, at right angles to each other, with a straight ruler attached to the meeting point of the two arms, and moveable upon a guide supported by the other extremities of the same. On marking the first diametrical line the instrument is placed at right angles to such line, and the centre of the circle readily determined.—A curious instrument is to be applied to omnibuses and other vehicles, whereby the weight of passengers is accurately registered, and those persons above the average weight are registered as liable to double fare.—A weighing machine, consisting of a platform, acting by means of a system of levers upon a vertical connecting rod, which operates by a rack and pinion upon a pendulum, the deflection of which from the perpendicular, indicated by a dial or index, determines the weight upon the platform. An extra platform rests upon knife edges at either side of the first, one edge of each lying upon the weighing platform, and the other edge touching the ground. These allow the carriage upon which the goods are placed to be gradually brought upon the weighing platform, therefore avoiding all jerking and inaccuracy of measurement of the pendulum. The pendulum registers the excess over a certain constant weight, and a second register, which counts the number of weighings, accounts for this constant weight, thus forming a very rapid weighing and self-registering machine.

Under the section of Stone and Clay Manufactures have been patented several machines; amongst the most important are —A Stone-dressing machine, in which the cutting chisel, instead of acting upon the stone by a blow, is actuated by a short crank or eccentric and connecting rod. The reciprocating motion of the chisel causes it to act upon the stone at the end of its stroke, and by the intense pressure it is capable of exerting at that point, chips it away, as fast as the stone, mounted upon a sliding carriage, is carried beneath by a gradual feed motion. A series of cutters, made to act alternately or in succession, is extended across the whole width of the stone.—In a Stone-drilling machine the drill-stock works between the grooved circumferences of two pairs of wheels, which, revolving in opposite directions, carry the drill-stock first one way, to give the blow, and then back again. The drill-stock is grasped or held by the two wheels of one pair only, a part of the circumference of the wheels of each pair being slightly reduced in such manner that while one pair is binding the drill-stock and giving it motion, the other pair serves only as a guide. The draw or binding part of the first pair, which gives the advance motion to the drill, is a trifle shorter than that of the second pair, in order to release the drill-stock just before the drill is ready to strike the stone. With this precaution the two pairs of wheels command both the blow of the drill and its progressive advance as the material is cut away. The turning of the drill is effected by placing the two wheels of the second pair a very little oblique to the direction of the drill-stock, thereby imparting to it a slight screw motion. These wheels are also made of smaller diameter than the first, to prevent any rapid return motion of the drill. In another of these machines, the drill-stock works through the hollow piston-rod of a small steam-engine, and is clamped thereto by an apparatus attached to the cross-head, which holds the drill-stock until just after the middle of the stroke, when, by the action of a fixed cam, it is unclamped, and proceeds with full velocity until it strikes the stone, before the piston-rod has completed its stroke. A spring reclamps the drill-stock, and it returns by the back stroke of the piston. The clamping apparatus causes the drill to rotate, and ensures its progressive advance to its work.

Under the section of Hydraulics and Pneumatics is patented a Turbine, the buckets of which are capable of adjustment for different heads of water, without changing the curvature of the buckets, by means of a sliding plate of the same width and curvature as the bucket; the moving of this plate outwards extends the curvature of the bucket, and diminishes the orifice of discharge.

Under the class of Civil Engineering and Architecture 38 patents have been granted, relating to railroads, hydraulic works, excavating and boring, bridges, &c.; but nothing particularly worthy of notice has been brought forward. 50 patents were granted for land conveyance, and 36 for mills of all descriptions.

The Report adverts to the impossibility and impolicy of the Examiners answering letters addressed to them, announcing discoveries, and requesting their opinion upon their novelty and utility. The examination necessary to decide these points would entail too much extra labour upon the Examiners, and any opinion or decision issued by them would undoubtedly commit the office in a way that would not be endured in any tribunal of law. Even a cursory opinion might embarrass the future consideration and disposal of the case, and should not be asked for any more than the views of a judge upon a question which he might be called upon to try. Persons requiring and interested in information respecting the practice and requirements &c. of the Patent Office of America, will find appended to these Reports a guide to the necessary routine.

## PADDLE-WHEELS.

AUGUSTE E. L. BELLFORD, *Patentee*, December 19, 1853.

(*With Engravings, Plate* XVII.)

THIS invention consists in arranging and combining the floats of paddle-wheels in such a manner that they form a continuous series of rhomb-shaped buckets all round the wheel. This method of arranging the floats prevents violent concussions when they strike the water, and holds the water upon which they act in an unbroken body, thereby rendering their action more effective than that of the ordinary floats.

Fig. 1, Plate XVII., is a front view of one of the improved paddle-wheels. The frame of the wheel, consisting of the bosses A, arms B, and rings C, is constructed in the usual manner, and strengthened by oblique stays *a*, *a*. The floats D, are made of sheet-iron, united together and to the arms by bolts or rivets, and arranged with their outer edges in lines running spirally round the wheel in opposite directions, at angles of about 75° to the axis; the intersection of these lines forming a number of rhomb-shaped buckets E, having their openings towards and from the centre of the wheel. The inner openings are contracted, and depart from the rhombic form, owing to the side angles being cut off and the figure made six-sided, thus giving the front angle such a form as to prevent back-lift in rising from the water. The number of buckets depends upon the width of the wheel; the one shown in the drawing includes three buckets. A number of triangular-shaped half-buckets will be unavoidably formed close inside the rings, but the wheel might be made of sufficient strength to dispense with the rings by uniting the floats and arms.

This wheel acts upon the water with a successive series of rhomb-shaped close buckets, of which the two front sides of the rhomb impart a propulsive effect, while the two back sides prevent the breaking up of the water upon which they act, and the consequent loss of their effect, and also from the front sides or propelling parts of succeeding buckets. The operation of this wheel is the same in whichever direction it turns, and as it is self-bracing it can be made of great strength.

*Claim*.—Arranging and combining the floats so as to form a series of buckets of rhombic or substantially similar form, as and for the purposes herein set forth.

## STEAM-BOILERS.

(*With Engravings, Plate* XVII.)

THIS invention has reference to the more perfect combustion of the gases generated by the ignition of the fuel; the attainment of a large extent of heating surface without subjecting any part to a very intense heat; the prevention of explosions produced by great diminution of the quantity of water; and the reduction of the necessary weight of metal and quantity of water in steam-boilers.

Fig. 2, Plate XVII., represents a vertical section through the centre of a boiler, constructed according to these improvements; and fig. 3, a horizontal section of the same, taken on the line X Y, of fig. 2. A, is the outer cylindrical shell of the boiler; and B, an inner cylinder, united to annular plates *a*, *b*, the space between them forming an outer water-jacket. C, is a cylinder or hollow frustum of a cone, united at its lower end to a cylinder D, open at bottom and terminating in a dome E, and at its upper end to the cylinder B, which also terminates in a dome F. The space between C and D, forms a second water-jacket, communicating with the outer water space through holes *c*, *c*, in the cylinder B, thereby maintaining the same level in both water-spaces, which are connected at bottom by a blow-off pipe *e*, and cleared out by one blow-off cock *f*. The outer shell A, rests upon a circular base G, containing the ash-pit and the fire-grate H. K, is a circular flue between the bottom of the outer water-space and the shelf I. J, J, are vertical tubes, connecting the flue K, with an upper flue L, formed by the dome M. Within the innermost cylinder D, are two vertical coils of tubing, N, N′, connected at their lower ends to the outer water-jacket, and terminating at top in two vertical pipes O, O′, reaching nearly to the top of the dome F, into which they open with their mouths turned downwards.

The water-heating surfaces of the boiler consist of the cylinders B, C, D, the dome F, and the coils N, N′; the gases, &c. rise, and are consumed in the cylinder D, and the space between the water-jackets. The products of combustion descend and pass off into the circular flue K, from whence they escape through the tubes J, J, to the flue L, and from thence to the chimney M′. The steam generated rises into the dome or chamber F, and passes off for use by any suitable contrivance at P. Steam is generated in and rises through the coils of pipe with such rapidity, that streams of water are constantly and forcibly driven through them into the steam-chamber so long as any water remains in the boiler; the water then descends to be again carried up, and thus a constant circulation of water is produced in every part of the boiler; and in the event of the water becoming low in the water-jackets, this circulation has the effect of keeping the heating-surfaces moist, obviating the danger of explosion, and preventing the plates from burning or any accumulation of impurities in the coils. The small quantity of water covering the heated surfaces becomes rapidly converted into steam, which passes by the pipe R, into the coil Q, in the space between outer and inner water-jackets, when it becomes surcharged with heat, and from whence it is conducted by the pipe S, to the engine. *d*, is a small pipe admitting a minute stream of water from the outer water-jacket into the pipe R, for the purpose of tempering the dryness of the steam. The form of the boiler is well adapted to withstand pressure without the aid of braces or stays.

*Claims*.—1. A boiler composed of an external water-jacket, with steam-chamber at the top, and with or without one or more inner water-jackets connected and in communication with the outer water-jacket, when either water-jacket is surrounded internally with one or more vertical coils of pipe, whose lower ends connect with one of the water-jackets, and whose upper ends discharge into the steam-chamber, substantially as set forth; 2. Drying the steam by passing it through a coil of pipe, within or between the water-jackets, substantially as set forth.

## MOULDING AND CASTING.

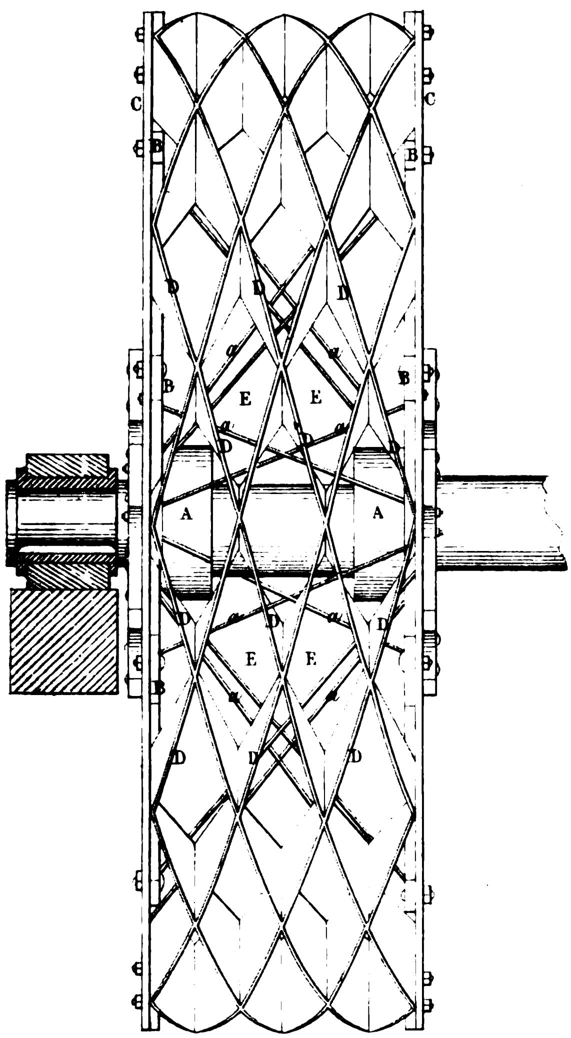
JULIAN BERNARD, *Patentee*, April 25, 1853.

(*With Engravings, Plate* XVII.)

THIS invention relates to a method of casting metals or moulding plastic materials of any kind; such casting or moulding being effected in a partial vacuum obtained by extracting the atmosphere from the moulds in which the metal or other materials are to be cast or moulded.

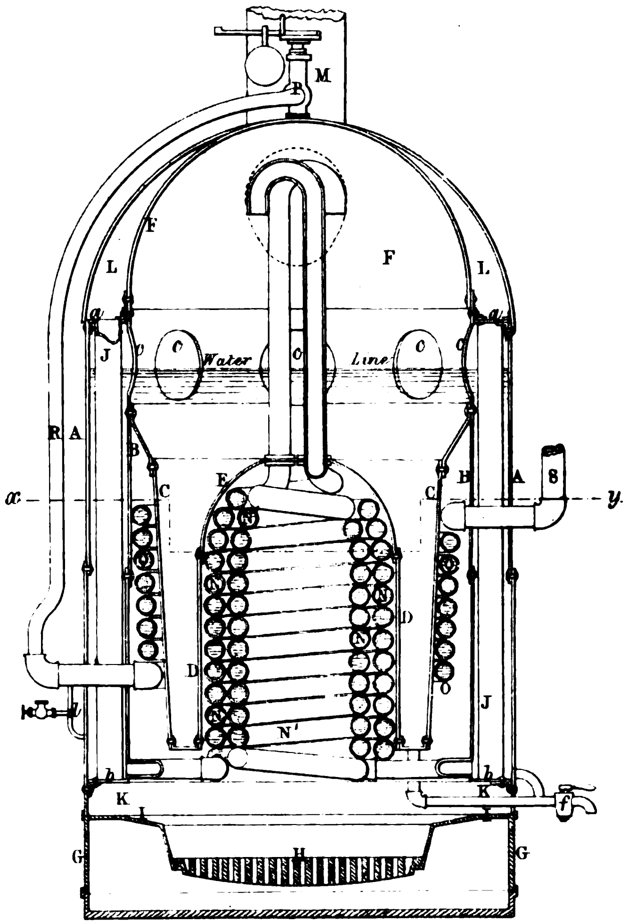
Improved Paddle Wheel.

Fig. 1.



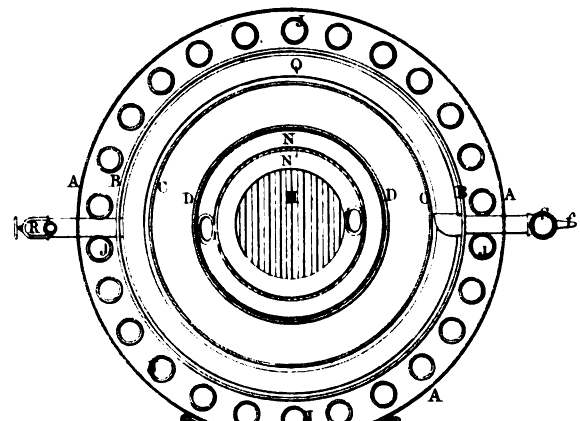
Improvements in Steam Boilers

Fig. 2.




Plan View

Fig. 3.



Improved Moulding Apparatus.

Fig 4

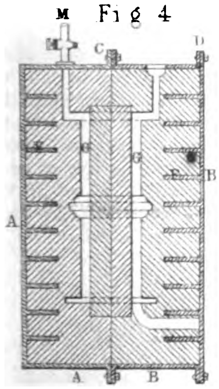
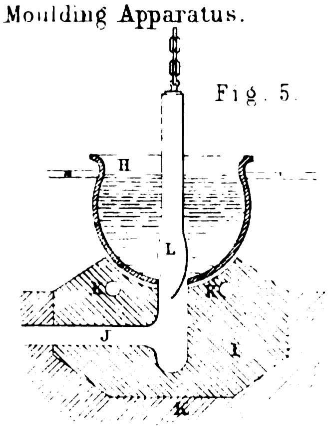


Fig. 5.



When metals are cast according to this process, the pot or crucible containing the metals has a hole in the bottom part plugged by a fire-brick or plug of any suitable material; the pot is placed over an air-tight channel communicating with the mould, which may be kept at any desired temperature by the application of steam or heated air, or cold water or air.

Fig. 4, Plate XVII., represents a vertical section of a moulding-box and mould for a steam-engine cylinder; and fig. 5, a section of the crucible or ladle of molten metal. A, B, are the moulding-boxes, joined together by flanges C. The box A, has its bottom cast on; the box B, is made in the ordinary manner, open throughout, but fitted with extra flanges at D, to receive the cover or plate E, which is bolted tightly up, to exclude as much as possible the external atmosphere from the interior of the mould G. The crucible or ladle H, containing the metal is supported on the fire-brick I, which is divided longitudinally down the centre of the channel or passage J. The ladle H, rests upon a bed of loam, which completely excludes the atmosphere from the channel J, and the interior of the mould. A plug of fire-clay L, is fitted into the aperture in the bottom of the ladle, and is there kept by the superincumbent pressure of the metal. A cock M, and flexible tubing connects the interior of the mould with an air-pump or other exhauster. When a sufficient vacuum is obtained, the cock M, is closed, and the plug L, in the ladle withdrawn; the metal is then forced into the mould by atmospheric pressure until it reaches the level of the cup N, which cup is closed before exhausting by a disc of metal or loam O. This disc is displaced by the rise of the metal in the mould, and indicates that a sufficient quantity has been run in, when the plug L, is immediately let down by a cord or chain, and the supply of metal consequently stopped. This system of casting produces a superior surface and sharpness of outline, the casting being perfectly free from air-bubbles or impurities. The moulding of plastic or soluble materials is effected in a similar manner to the method above described.

## MANUFACTURE OF IRON.

Henry Leachman, *Patentee*, April 6, 1853.

This invention consists in treating iron by means of a combination of the following materials, for the purpose of producing a more plastic and malleable iron than heretofore:—Common brick-dust or calcined clay, 120 lb.; common salt (pounded fine), 600 lb.; and black oxide of manganese, 280 lb. These materials are thoroughly intermingled and reduced to a powder, and added, in quantities varying from 4 lb. to 10 lb. weight, to the metal during the boiling process to which pig-iron is subjected. Metal of very poor quality requires 10 lb. weight of the powder to 420 lb. of metal.

## SELF-CLOSING VALVE FOR PREVENTING SMOKE.

Thomas Symes Prideaux, *Patentee*, December 27, 1853.

This invention consists of an apparatus to be applied to the fire-doors of furnaces, with the view of regulating the admission of air, in order to improve the combustion of the smoke, gases, &c., economise fuel, and at the same time to prevent the radiation of heat outwards. Fig. 1 of the annexed engravings is an elevation of the valve as fixed to a furnace-door; fig. 2, a sectional plan; and fig. 3, a section of the same. The front of the apparatus constituting the panel of the furnace-door, consists of a series of shutters *b*, moveable on axes *c*, so as to be capable of opening and shutting like Venetian blinds. Behind these moveable valves or shutters is a series of parallel plates *l*, fixed at a slight angle; a second series *m*, is then fixed at an opposite angle; and then a third and wider series of parallel plates *o*, which do not incline; *n*, and *p*, are air-spaces between each series. By means of the slight inclination in opposite directions given to the first and second series of plates *l*, *m*, the direct outward radiation of the heat from the fire is prevented although the air has free ingress, and the inclination, being at an angle to the axis of the line of draught, has the further effect of causing the current of air slightly to impinge upon the surface of the plates in its passage by which means the heat is more effectually extracted.

The shutters or valves are caused gradually to close in the following manner. Each shutter has attached to it an arm *d*, attached at its other end by a pin-joint to the bar *e*, to which motion is imparted by a rod *f*, connected at its lower end to the bar *e*, and at its upper end to the lever *g*, the gradual descent of which in any required time is effected by its being connected with a piston *i*, traversing a water-cylinder *h* (shown in section in fig. 4), which piston, by means of a valve, allows a free passage to the water from above to below, but resists its passage in the opposite direction. When the water is forced by the gravity of the lever, piston, and their appendages, from below to above through the narrow channel *j*, the size of which at the bottom is adjusted by the screw *k*, so as to regulate the time occupied by the passage of the water, the gradual descent of the piston and closure of the shutters is effected with the greatest nicety.

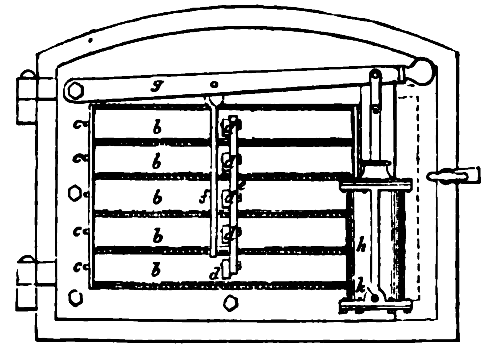


Fig. 1.

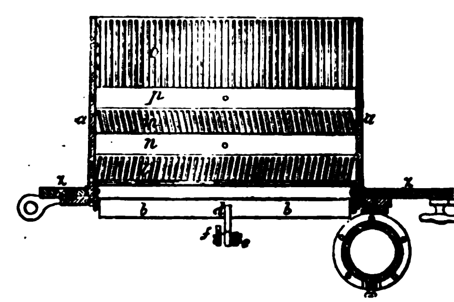


Fig. 2.

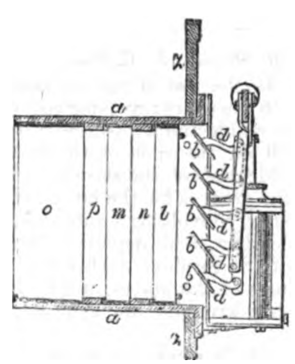


Fig. 3.

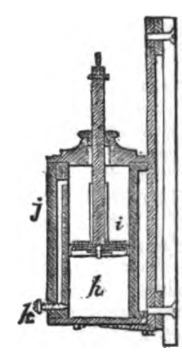


Fig. 4.

So perfectly does the above arrangement of plates, air-spaces, cylinder, &c., fulfil the desired object—viz., that of isolating the heat radiated against the inner surface of the fire-door, so as to confine it in the interior, and ensure the whole being transferred to the entering current of air during the periods in which the valve is open,—that after the valve had been closed ten minutes, and the innermost row had become red-hot, a thermometer with its bulb in contact with the face of the shutters indicated only 64 degrees. This valve may be seen applied to three furnaces at the Panopticon, Leicester-square.

## COATING IRON AND SHIPS' BOTTOMS.

HENRY BROWNING, *Patentee*, January 18, 1853.

THIS invention consists in combining the following ingredients, each in the proportion of one part by measure: white-lead, red-lead, and black-lead, together with one quarter part, by measure, of the sugar-of-lead. If the colour of the paint is required to be lead-colour the red-lead is omitted. These matters are ground with spirits of turpentine, to which is added gum-copal dissolved in turpentine (white copal varnish). A thin coating of this mixture is then applied to the iron or ship's bottom, the sugar-of-lead being reduced in quantity or left out in the subsequent coatings.

## RECENT AMERICAN PATENTS.

[Reported in the Journal of the Franklin Institute.]

*Daguerreotype Apparatus.* J. Brown.

The nature of this invention consists in the employment of an ornamental diaphragm, with a suitable opening placed in a suitable position in front of the person or subject to be represented, for the purpose of producing a portrait or picture, with an appropriate or tasteful ornamental border, either with or without the name of the person or subject and the name of the artist. The diaphragm may be, and will be mostly, used in conjunction with a background, such as is now sometimes, illustrative of the character of the person or subject represented.

*Claim.*—The employment of a diaphragm with a suitable opening, through which the person or subject is presented to the camera, when the said opening is surrounded by ornament or embellishment, for the purpose of producing a portrait or picture with an ornamental or embellished border.

*Dressing Staves.* J. D. Elliott.

The nature of this invention relates more particularly to the use of a transversely-inclined bed, upon which the staves are fed into the cutters, so as to adapt the machine to the dressing of thick or thin, tapering or wedge-shaped riven staves, with the grain of the wood, without separately adjusting the machine or assorting the staves.

*Claim.*—The combination of the transversely-inclined bed with the swivelled roller, for the purpose of adapting the machine to the dressing of riven staves with the grain of the wood, whether thick or thin, tapering, or inclined from edge to edge, without any separate adjustment for the various sizes.

*Finishing the Ends of Staves.* J. E. Warner.

This invention consists—1. In the use of circular-saws to cut the staves to equal lengths; 2. In the use of revolving cutter-heads, having in each three sets of moveable and adjustable cutters; the first set for forming the bevil on the ends of the staves; the second set for equalling the thickness of the staves at each end; and the third set for cutting the grooves for the heads; 3. In the use of a rotary bed, which, slowly revolving on its axis, carries the staves to the saws and cutters, and deposits them when finished on the opposite side of the machine. This bed is made to yield to the varying thickness of the staves, and by means of weights the staves, while being wrought, are kept steadily in contact with fixed stops.

*Claim.*—A feed-bed revolving in bearings which are capable of being moved by weights, springs, or other means, towards the beds or stops on which the back or outer side of the stave is supported, the extent of such movement depending upon the thickness of the staves operated on. Also, the combination of the feed-bed with the saws, cutters, fixed stops, and moveable frame, and what are substantially their equivalents.

*Chuck for Cutting Barrel-Heads.* F. Fruit.

The nature of this invention consists in holding the material of which the barrel-head is cut by means of a chuck, having a series of centres, placed in circular form, and concentric with the periphery of the chuck. Each centre is provided with a spiral spring, which enables the centres individually to give or yield, so that the different pieces forming the barrel-head may vary in the thickness, and still be firmly held by the chuck.

*Claim.*—The chuck, constructed as shown and described—viz., two circular discs, connected by studs and centres, placed between the studs, any proper number of studs and centres being used, the centres passing through both the front and back discs, and having collars upon them, each centre being provided with a spiral spring, which is placed between the collar and the inner side of the back disc, and by which springs each centre will yield or give, independently of the others, so that the different pieces forming the barrel-head may vary in thickness and still be properly adjusted and secured between the face-plate and chuck.

*Ventilators.* J. Leeds.

This invention consists in arranging a series of downwardly-inclined curved openings in the outer case or shell of the ventilator for taking in and directing downward into the building to be ventilated, a current or currents of pure air, and in connecting therewith a passage in the centre of the ventilator, through which the impure air may be drawn upward by an accumulated or increased draught over the top of said passage; also, in the manner of increasing the draught across the top of the ventilator to aid the upward current of air through the centre passage.

*Claim.*—The combination, in one case or shell, of the series of downwardly-inclined curved openings in the outer shell, for taking in and directing downward a column of pure air, with the centre pipe or opening crowned with two frustrums of cones, with their apices towards each other, for producing a counter-current, and carrying from the apartments to be ventilated the impure air, and increasing said ejecting current, the whole requiring but a single opening in the roof.

*Paddle-Wheels.* W. H. Muntz.

This mode of constructing the paddle-wheels consists—1. In making the supports of the buckets, a cut-water wheel, and two wheels of smaller diameter; 2. Of forming each bucket of a float and guard made to stand at an angle to each other; 3. Of making the guard to extend from the rim of the cut-water wheel to the other or smaller wheel, and so that the guard shall not only pass edgewise through the water, but endwise into the water, the float being made to project inwards from the guard, as stated. And in combination therewith, making the float narrowest at its outer end, or at the cut-water wheel, and gradually increasing in width towards its inner end.

## INSTITUTION OF CIVIL ENGINEERS.

*Feb.* 28.—JAMES SIMPSON, Esq., President, in the Chair

THE paper read was "*On the means of attaining to uniformity in European Measures, Weights, and Coins.*" By JAMES YATES, M.A., F.R.S.

Believing that the only way of attaining the object in view was by the adoption of the French system of measures, weights, and coins, and that such a step would be attended by great advantages in regard to exactness and convenience, as well as uniformity, the author first gave a brief account of the origin and principles of that system. The method of determination of the "mètre," as the standard of linear measure, and the representation of it by the bar of platinum, deposited in the National Archives at Paris, was narrated. A description was then given of the mode of deducing from that standard all other measures of length, of superficies, of solidity, and of capacity; also of the determination of the fundamental weight, called the "gramme," and the derivation therefrom of the "franc," containing five grammes of standard silver and forming the basis of the ascending and descending series of coins and monies. The advantages of the decimal divisions and multiples, and of the names applied systematically to all, were asserted, notwithstanding the partial recommendations of the octonal, and still more of the duodenal methods of computation.

Adverting to the successive obstructions and difficulties which the system had to encounter from political disturbances, as well as from popular prejudice and the previous habits of the French nation, the author mentioned its final establishment during the reign of Louis Philippe, and its gradual extension and steady progress subsequently to that period, both in France and in many other of the continental kingdoms. As practical examples, specimens were exhibited, showing some of the forms in which the French measures were now sold and applied to all the purposes of common life.

Considering the success which had attended this grand project of social improvement; the generous and enlightend spirit in which it was conceived; the difficulties which it had surmounted; the successive amendments which it had received, as the result of experience during the course of more than half a century; the exactness of its principles, and the beauty of its adjustments; and the almost universal approval accorded to it by the millions of persons who now employed it in their daily intercourse and occupations, it was considered manifestly impossible that it should ever be abandoned for any other system wherever it had once been adopted. If this were true, it followed that the French system must remain, whatever other systems might be discarded, and it might consequently become universal. It was therefore argued, that it would be wise to take advantage of the progress towards uniformity thus made, and to use all means for extending the influence of that system.

As the French had not hesitated to adopt British inventions when the advantages were made apparent, it was argued this country should be equally willing to adopt any amelioration, from whatever source it might be derived. No nation was better qualified than the French to introduce improvements in the theory and practice of metrology. If they had not already offered an admirable system to the world, all civilised nations would look to them as perhaps the most able to invent such a system, on account of their acknowledged attainments both in theoretical and mathematical science, and their dexterity in certain branches of mechanics. No narrow prejudice or national antipathy should prevent an international combination for the promotion of a scheme, fraught with advantage to the interests of commerce, of science, and of philantrophy.

In addition to the objections urged by theorists, there were others equally formidable, arising from habit and popular prejudice. These, it was contended, must be overcome by the combined efforts of the government and the people. The government had under its control infinitely the greatest amount of measuring and weighing, and counting of money, in the kingdom, and consequently had the greatest interest in introducing a system which would be attended, in addition to numerous and far greater benefits, with a saving of a very large amount (probably a quarter of a million annually) in the collection and management of the revenue. But the government could not possibly effect this great change, apart from the people; therefore the people should cooperate with, even if they did not commence the work, and it was a question whether it was not best that the change should begin at the bottom of the scale. The French system was so simple and beautiful that it could be taught, in a week, to the children of all schools for the poor, throughout the kingdom, and they would take a pleasure in diffusing the knowledge of it among their parents and elders. Decimal methods of computation, and the ability to use the French measures, weights, and coins, having been propagated among the poor, would necessarily be well known to the rich, and would thus soon become familiar and habitual among all classes of the people.

The objection made to the use of French terms, such as *Franc*, *Centime*, *Mètre*, &c., was refuted on various grounds. These terms were not in fact French, but rather Greek and Latin, and they were on that account at first to some extent repudiated by the French. On the other hand, Avoirdupois and Troy (*Troyes*) weight being French, the English were now only asked to exchange old and inconvenient French weights for new ones, which were better. But the introduction of numerous terms with other fashions and usages from France, and their constant recurrence, showed that this objection was much over-rated. Even if it were a valid objection in point of fact, it was one of little moment: for, if the terminology was objected to, the system might be taken without it. The Piedmontese, for example, used the French monetary system, although they called a "Franc" a "*Lira.*" As the Arabic numerals, which were used wherever computation by tens was practised, were the signs of numbers, which were called by different names in different countries, and yet were everywhere received in the same sense, so the same measures, weights, and coins, might be known in the various parts of the world under different denominations, and yet be perfectly understood and employed by common agreement throughout the earth.

The author exhibited a scheme of coinage, having the "franc" for its unit, the scale ascending to one hundred francs in the one direction, and descending to the one hundredth part of a franc, called a "centime" or "cent." (*pars centesima*) in the other direction. He maintained that the "franc," occupying a middle place between the highest and the lowest coin, and being of that value which was either on a par with the great majority of purchases and payments in this country, or certainly not at all below them, was well fitted to be taken as the middle term, and in this respect was preferable to the pound sterling, or even to the dollar. At the same time, nothing could be better adapted to secure facility, promptitude, and correctness, in keeping accounts, than the reckoning by francs and centimes. He thought it useful to have a gold coin of one hundred francs, and a centime (perhaps of brass, on account of its large dimensions), in order to exhibit both extremities of the series to the eye, and to make that series complete. He considered the rare occurrence of these smaller coins to be no objection, but the contrary; because it would show the middle term was fixed where it ought to be—at that point where coins were in most constant requisition for the purposes of trade and daily intercourse

Remarks were offered, showing the application of the subject to the employments of shopkeepers and retail traders, merchants and bankers, stock and share brokers, and more especially to railway companies; as also its almost indispensable necessity with a view to international postage.

In conclusion, it was suggested that all persons who were interested in this question, either on commercial grounds, from the love of science, or as the friends of peace and human progress, should use every means of co-operating with the government, and either by forming associations, or otherwise, endeavour in every possible manner to induce the mass of the people to become acquainted with the principles and advantages of the French system, and thus with all convenient speed to introduce the knowledge and the use of it, not only in Great Britian and Ireland, but in all the colonies and dependencies of the kingdom, and through the influence of example eventually to extend it to the United States of America, and other independent countries.

*March* 7.—The evening was devoted to the Discussion of the above paper. After describing the steps taken to induce the attention of the legislature to the subject, and reviewing succinctly the evidence of the different witnesses examined before the Select Committee on Decimal Coinage, and the report resulting from that inquiry, the advantages to be anticipated in all matters of money accounts were first dilated on, and then the translation of the present diversified weights and measures into one uniform and decimally-divided system was insisted on. It was urged, that great facilities would be introduced in keeping accounts and making calculations; that the pound sterling being adopted as the integer, the whole of the coins in present use might be retained, by only stamping their decimal value upon them, and thus keeping them in circulation until a new decimal coinage could be prepared. The proposed coins were shown to be sufficiently small for the purposes of the poor, for whom the quantities of merchandise would always be adapted to the purchaser's means; and the pound sterling remaining as the integer, was urged to be all that the large bankers and merchants could desire.

It was argued, that there were great objections against endeavouring to assimilate the coins of this country with those of other states inasmuch as it would be impracticable to get all countries to agree; despotic monarchs would still continue, as heretofore, to debase the value of the coinage to meet the exigencies of the moment, and even republican states had depreciated the value of their money; so that, if all coins were to-day universally of the same standard and value, there was nothing to prevent their being all wrong to-morrow. Therefore, all that could be done was to decimalise the currency of this country without reference to that of other countries, and it was then thought that eventually the same adjustment of weights and measures would follow. The work of General Sir C. W. Pasley was quoted, to show the inappropriateness of the mètre and its subdivisions for this country; it was urged, that even in France its use had only been enforced, during the Revolution, by the harshest means, and that even then the *systeme usuel* (feet and inches) had remained in force for nearly half a century, and in spite of decrees was even now scarcely abolished. The further propositions made by the General, for a decimal system based on the existing coins, weights, and measures, were carefully examined. Professor Airy's evidence before the Committee was dilated on, and it was endeavoured to be shown, that any attempt to assimilate English and foreign coinage must fail, if only from the force of public opinion and the passive resistance of those who had no interest in making any change.

It was a question of immense difficulty how to establish a natural basis for a standard; it had been, in almost all cases, found impossible to establish one correctly, and therefore an arbitrary standard had been preferred. The precautions taken for preserving correct types of the standards for England were detailed. The introduction of the decimal subdivision of the troy for the use of the Bank of England and the bullion dealers, was quoted as an example of what necessity would do naturally, and was used as an argument to urge civil engineers, architects, and builders, to introduce some uniform scale of decimal measures, to which money values would be brought to assimilate more easily on the decimal than on any other system. It was shown, that the government could only "enforce" a decimal division of the coins of the realm, but it might "permit" eventually such an arrangement of measures and weights, as would be found most convenient by merchants and traders for the purposes of commerce. The system of the franc, and the penny, was strenuously urged, as being the simplest and best adapted for the wants and habits of the labouring classes.

It was contended by others, that the proposition of the Committee on Decimal Coinage, for adopting the pound sterling as the integer and dividing it into 1000 mils was untenable; inasmuch as besides unsettling tolls and postage stamps, authorised by Act of Parliament, it would alter the prices of produce of all kinds, and only in a few cases supply equivalent rates; nor would it meet exchanges with France and other countries without dividing the cent. into most inconvenient fractions. It was therefore urged, that it would be more convenient to adopt a lower integer, proposing either a coin of the value of 25 pence = 100 farthings or cents.; or a coin of the value of 10 pence = 40 farthings or cents. The latter was considered to be more in harmony with the monies of France, Holland, America, and other countries, where the decimal system had been already adopted. The coin of $\frac{4}{10}$ths of a farthing would equal the centime of France. The exchange with other countries would be met within ⅛th of a cent., and manufacturers would have a denomination to suit the smallest variation in prices or profits, without using the extreme fractions now resorted to.

If it was admitted that the true arithmetical and scientific division of the integer was into 100 parts or cents., it was contended that no difficulty would be experienced in the practical introduction of the system into commerce, and into retail trade; that its adoption would lead to a more correct method of estimating profits and losses and of keeping books, and that it would facilitate calculation and the receipt and payment of duties, taxes, and monies of all kinds.

As early as the year 1832, Mr. Babbage had, in his 'Economy of Manufactures,' drawn attention to the decimal system, as being the best adapted for facilitating all mercantile calculations, and had suggested the conversion of the present currency into a decimal series.

It was stated, that at the period of the Great Exhibition in 1851, M. de Vinsac, Member of the Academy of Macon (France), was deputed by that Society, to endeavour to induce the adoption in this country of a system in weights, measures, and coins, somewhat analogous to, if not identical with, those of France. That period, however, was not favourable for the consideration of the subject, and M. de Vinsac had left with the Secretary of the Institution of Civil Engineers, certain documents from which should now be culled and translated all that might apply to the question, in order to their publication with Mr. Yates' paper.

*March* 14.—The Discussion on the above subject was resumed and continued throughout the evening, and not being concluded, was adjourned until the meeting of March 28th. The abstract of the Discussion on both evenings will be published in our next number.

*March* 21.—The first paper read was a *"Description of Martin's Improved Jacquard Machine."* By EDWARD LAFOREST.

After stating the very general application of Jacquard machines to all ornamental weaving, the Paper described the old machine, and the manner in which the patterns were produced, by means of bands of punched cards, acting on needles with loops or eyes, which regulated the figure. It showed also the great wear and tear to which these cards were subjected, indeed so much, that for the carpet trade they were often required to be made of sheet-iron.

In Martin's new Jacquard machine, the object had been to substitute for the heavy cards a sheet of prepared paper, punched with given apertures like the cards of the old machines, but instead of being a series of pieces 2½ inches wide, laced together, the punched paper formed a continuous band, only ¾-inch wide, thus so diminishing the bulk that the weight of the new band as compared with that of the old cards was in the proportion of 1 to 11. The method by which this desirable result had been attained was then explained to be chiefly by an arrangement which permitted the 400 spiral springs on the needles, used in the old machine, to be dispensed with, when as a consequence the force and wear and tear due to their resistance would be done away with, and fine and light wires could be made to do the work of strong and heavy ones. In order to render this clear, one of Martin's machines, with a part of an old machine, and bands of equal numbers of cards under each system were exhibited.

The next point demonstrated was, that like the bulk and weight, the cost of the cards under the new system would be greatly reduced. It was shown, that by a new system of punching machinery, the bands could be cut from a design, previously perforated, at the rate of 3000 cards per hour, and any number of duplicates could be produced with equal celerity; it was also stated, that by these means, when a pattern became fashionable, any number of looms might be set to work on it, in about as many days as it had previously required weeks under the old system. The price of the old cards was 6*s*. 9*d*. to 8*s*. 6*d*., and upwards, per 100, for new sets, and 5*s*. 6*d*. for recuts; whereas the new paper-bands would cost 1*s*. per 100, and 6*d*. per 100 for recuts. The comparison of cost of 3000 cards (an average band) would therefore stand thus:—

| | Cost. | Weight. | Length. |
|---|---|---|---|
| 3000 cards @ 6*s*. 9*d*. ℔ 100 | £10 2 6 ...... | 90 lb. ...... | 600 ft. |
| 3000 new bands @ 1*s*. ℔ 100 | 1 10 0 ...... | 8¾ lb. ...... | 63 ft. 9 in. |

In reference to durability, it was stated that a band had been in constant work for two years, although used on a heavy waistcoat-piece.

The second Paper read was *"An Account of the Deep-Sea Fishing Steamer 'Enterprise,' with Ruthven's Propeller,"* by D. K. CLARK, Assoc. Inst. C. E.

The vessel was described as having been built for the "Deep-Sea Fishing Association of Scotland," under the direction of the author, the consulting engineer to the Company, who had recommended the trial of Ruthven's propeller for fishing uses, in preference to the paddle or the screw, chiefly on account of there being nothing likely to interfere with the fishing nets; and also because the success of the previous trials of this means of propulsion, on board of boats 30 feet and 40 feet in length, when a speed of 7 miles per hour was attained, appeared to warrant its being tried on a larger scale.

The chief dimensions of the *Enterprise* were stated to be: length on deck, 95 feet; length at the water-line, 87 feet; breadth of beam, 16 feet; depth, 8 feet; draught to load water-line, 4 feet; burthen, 100 tons. The propelling power was derived from two pairs of horizontal oscillating cylinders, 12 inches diameter, and 24 inches stroke (with corresponding air pumps and condenser), working on a vertical crank-shaft. There was one cylindrical boiler, 6 feet diameter, and 5 feet long, with two through fire-tubes, 22 inches diameter, and 105 return flue tubes, 5 feet long, and 2 inches internal diameter. The propeller consisted of a fan-wheel, or centrifugal pump, 7 feet diameter, with curved blades, keyed on the lower end of the crank-shaft; it revolved horizontally in a water-tight wheel-chamber, into which the water from the sea flowed along a covered passage or water-chamber, through crescent-shaped openings in the bottom of the hull; and the water was expelled laterally, from the fan-wheel, in two continuous streams, by curved pipes with nozzles 10 inches diameter, through the sides of the hull. The nozzles worked in collars affixed to the sides, so that they could be pointed astern or ahead, as required for forward or backward motion, or vertically downwards when the vessel was to remain at rest. These changes were made rapidly and easily, as the nozzles alone were operated upon, whilst the engine continued to work at full speed. By setting the nozzles in opposite directions, one pointing ahead and the other astern, the vessel could be turned on the spot, swinging on her beam, without the aid of the rudder; the vessel could thus be steered by the nozzles, in case of the rudder being disabled. In fact, the manœuvring of the vessel was entirely in the hands of the persons on deck. The fan-wheel and water passages were entirely of wrought-iron, and all the parts were formed to avoid sudden enlargements or quick turnings, and the consequent absorption of power in the passages by friction and eddies. The motion of the vessel was very smooth, and all tremulousness was avoided by the uniform and continuous action of the propelling streams of water.

In a trial trip with the *Enterprise* on January 16th, from Granton to Kirkaldy and back, a distance of 10½ miles each way, the average speeds obtained were, 9·69 miles per hour going, and 9 miles per hour returning, giving a total average of 9·35 miles per hour, running against the tide for the greater part of the trip, and with a breeze ahead on the return trip. The engine made 50 revolutions per minute, and was calculated to have exerted 40 indicated horse-power, from the observed average pressure of 20 lb. in the boiler, with the valve-gear cutting off at one-sixth of the stroke. The consumption of fuel averaged 5 lb. of coal per estimated horse-power per hour. On another occasion, in a trial of her speed with one of the Granton and Burntisland ferry-boats, the *Enterprise* kept pace with the ferry-boat, at the regular speed of 12 miles per hour, the engine making 70 revolutions per minute.

In the estimate of the efficiency of this method of propulsion, with respect to the power applied at the fan-wheel shaft, three sources of loss were admitted: first, the friction of the water in passing through the fan-wheel and passages; second, the excess of the effluent velocity of the water at the nozzles, above the speed of the vessel; third, the elevation of the water-jet above the sea level. The first had been found, by careful experiment, with a small model, to amount to 16 per cent. of the power applied to the wheel-shaft; the second was estimated, from the known data, at 12 per cent.; and the third at 8 per cent.—making a total loss of 36 per cent., and leaving a useful balance of 64 per cent. of the power applied to the wheel-shaft.

Reference was made, for comparison, to the performances of Appold's pump, and of Barker's mill, as tested by Mr. W. M. Buchanan of Glasgow. After suitable allowances were made, corresponding to the loss at the nozzles, and the loss by elevation of water, the following percentages of useful effect were arrived at:—Ruthven, 64 per cent.; Appold, 57 per cent.; Barker, 67·8 per cent.; giving a mean of 63 per cent. of the power applied to the wheel-shaft. The friction of the engine was taken at 20 per cent. of the indicated power on the piston, leaving 80 per cent. delivered at the wheel-shaft. It therefore appeared, finally, that of the whole indicated power of the engine, as applied to work Ruthven's propeller, 50 per cent. was lost by friction and other causes, leaving a balance of 50 per cent. for useful work done. It was further argued, that by careful design, and good proportion of parts, so as to reduce the friction of the machine, the excess of velocity of the effluent water, and the elevation of the nozzle, 70 per cent. of the total indicated power of the engine might be utilised by Ruthven's propeller. The draught of the vessel during the trial was stated to be 3 ft. 2 in., and the immersed midship section 40·5 square feet. The united area of the nozzles being 1·09 square feet, the ratio of the area of propulsion to the immersed section was 1 to 37. To the load water-line, the immersed midship section was 55 square feet, and the ratio 1 to 50.

Many advantages of Ruthven's propeller for large vessels were pointed out and contended for. Several nozzles could be applied to one vessel, one acting for another in case of accident; whereas paddles and screws could not be so multiplied, and a number of engines and nozzle-propellers of moderate size, worked at high speeds, would it was contended be less weighty, more compact, and more manageable, for a large vessel, than the huge engines and appurtenances required on the present system.

## ART IN WASHINGTON.

The capital of this great nation is becoming something better than a mere hotbed of politics. Heretofore it has been exceedingly destitute of the attractions belonging to high art, but there are decided symptoms of a change for the better. First rate specimens in painting, sculpture, and architecture, are now appearing there.

Guire's and Corcoran's galleries are now open to the public Tuesdays and Fridays, presenting to the lovers of the beautiful many very clever original works, and respectable copies of renowned master-pieces. Corcoran's collection, in particular, is worthy of attention. The mansion is new, and presents a fair sample of the Romanesque style applied to domestic use. The picture gallery is appropriately arranged, with a concha recess opposite the entrance, wherein stands Powers' Greek Slave, well lighted from above. "Mercy's Dream," by Huntington, occupies a prominent place on one wall, and a pleasing variety of landscapes and other compositions hang opposite. Beneath the above are Cole's two magnificent pictures, exemplifying "The Spirit of the Middle Ages," and would be gems anywhere.

In the new square opposite the President's house, stands the equestrian statue of General Jackson in bronze, by Mills. The action, features, and general expression are bold, natural, and altogether admirable. It is a fitting exponent of the spirit which occasioned its creation, alike invincible at the council board and on the battle-field, ever courteous towards the gentle, and fearless before the strong.

The Washington Monument is constructing of white marble, in the form of a colossal obelisk, after the manner of that on Bunker Hill. But this one is to be surrounded by a circular temple, in the Egyptian style, a great incongruity, we think. But the shaft rising above ordinary objects, and seen at remote distances, will add much artistic expression to the metropolis. Let it proceed.

The Smithsonian Institute is nearly finished outside, and is occupied in part as originally designed. Taken as a whole, it is a striking object in the view, and is a valuable addition to our architectural wealth. It is composed on a reduced scale of nearly all the leading traits of the Norman style. A baron's castle forms one end, with corbelled chimney flues and clustered tops, canopied porch, arcaded terrace, machicolated parapets, and belltower; a Norman chapel at the other extreme, with triplet lights, rose windows, corbel-course cornices, apsis end, depressed entrance and groined roof; a Norman monastery between these, and connected with each by cloister arcades of the earlier and later types of the style, the transepts of the main body being formed by the two grand entrances at opposite sides. These are flanked by square and octagonal towers, each different from the rest in proportion, and all rather happily combined. Water tubes, buttresses, foliated openings, bay windows, niches, corbel-courses, embattled parapets, soaring turrets, and quaint finials, characterised by the bold and diversified mouldings of the twelfth century, give a new combination at each remove, and present a perpetual rest all around. The supreme tower, buttressed on the right of the front entrance, and surmounted by the octagonal lantern which rises so gracefully out of the cluster of turrets at its base, is a fine study, even to one familiar with Normandy in general, and the transepts of Rouen cathedral in particular. If the miserable stucco groining behind the beautiful stone fretwork in the arches at the base were displaced, that there might be harmony in the work as well as design, the architect's name would read better where it stands.

Romanised Corinthian and Ionic have been the modes in which national commissions have formerly been executed. The Patent Office was the first one started after the Doric manner; and had the material been as good as the Post Office, it would have been a vastly finer building. New wings are now building, of granite foundation and marble superstructure, and will add greatly to the attractions at Washington. The portion recently finished wares the air of calm majesty common to this order, when realised in proper substance under a master's hand. And such is Thomas W. Walker. It is well for American art that he has the supervision of the old as it is repaired, and of the new, as it is created for the use of our republic.

The grandest work of the age is the extension of the Capitol. This is in two portions, equidistant from the present edifice, and to be connected therewith through colonnaded corridors. Granite from the South and marble from the North, in immense quantities and of the most admirable texture, are in hand, already assuming shapes of substantial grandeur. The rusticated story is done, and the temple proper is begun. Marking the base of this is a sculptured stringcourse, going quite round. This ornament is indecorous, as would be a strip of calico bound about the trunk of a mighty oak. It is not the place for adornment; but there is no help for it in this instance, since the older portion immediately adjacent was so done for, and a return to classic purity at once would be too abrupt. Most of the openings of the old building are square-headed, and yet carry a cumbrous keystone over each. Why a horizontal member should be so cut through, and by a bevel that must more than annihilate all its strength—two halves of a lintel loaded by a central weight—is more than we can explain. No Greek ever saw such a solecism in art and such a blunder in construction. Mr. Walker happily mitigates the offence by inclosing his openings with a segmental arch, quite low, thereby giving the keystone something to do—the great lubber who has no business there, any how, but is too bold in his impertinence not to be immediately missed. The further the master gets above the realm of grovelling comparison, the more does he shake off incongruities and approximate perfection. According to the working drawings, the mouldings, entablatures, and pediments will round gently in their shadows or cut sharply in their lights, as when the first models augmented charms about the Acropolis. The truss, as a flanking feature to the head of the many openings, is often repeated in the parent structure, and everywhere, as is usual with artizans, looks like a thing stuck on, and just ready to slide down. But the continuator of the great design proposes, while he retains all the conventional elements of the truss, so to blend it with the integral jamb as to render it constructive as well as decorative, in a manner palpable to the critical eye and grateful to tastes refined. But the most magnificent external feature will be the eastern colonnades. There has been little pure Corinthian art since the Choragic monument of Lysicrates. Perhaps the only pure specimen on a large scale in our country, or for two thousand years before, is the Girard College. In that Mr. Walker adhered to the order as transmitted by Stuart, but re-cast all the proportions, in order to regain the same perfect symmetry on a scale vastly greater than Greece ever knew. But in the present undertaking, the architect trusting yet more to independent genius, will excel that masterly monument, by keeping closer to nature in the florated details. He has made a special study of the acanthus, and we may confidently expect from him capitals which from necking to abacus, through all the volutes, will seem to wave with flexile beauty in mid-air. The edges of the leaves are not to assume the astute and serrated aspect of carpenter's foliage, but the infinite ease and variety which signalise the handiwork of the great Creator. In the foliations of the interior apartments, we understand the architect designs to incorporate all the leading characteristics of the graceful and grand vegetation peculiar to our national domain. His facility at original composition and elegant execution is well indicated in the new library, which was projected while the ruins were yet smoking, and is now completed, ready for congressional use, and an honour to the land.

The new Senate Chamber, however, will doubtless constitute the chief glory, as is fitting, of the Capitol. The approaches, unlike the present, will be spacious, luminous, and direct. The forum itself will be worthy of that great deliberative and executive body. Immediately in the rear, and contiguous to the diameter of the more public amphitheatre, will be a spacious rectangular hall, the floor, walls, ceiling, all of purest marble, relieved by the richest paintings, and adorned by the noblest sculpture American genius, inspired by American patriotism, can produce. Should the works already projected be consummated under the auspices of such inventive genius as is at present employed, and with the facilities so abundantly at our control, then may Washington present to intelligent foreigners, art, as well as statesmen, second to none in the world.

The new group by Greenough has just been opened on the pedestal opposite Persico's Columbus; and the last panel in the Rotundo will soon receive Powell's De Soto. Perhaps he is the youngest citizen who ever received a national commission, and who would say that his work is inferior to the oldest? The circle of art thus finishes with "the little Westerner" in its first cycle. Hereafter, from remoter regions of our political union, yet to embrace even more than "the great West," the grandest productions will appear in all the realms of literature, science, and artistic excellence.—*American Paper.*

## ROYAL INSTITUTE OF BRITISH ARCHITECTS.

*March* 6.—EARL DE GREY, President, in the Chair.

The Medals and the Premium in Books awarded during the Session were presented by the President as follows:—

The Royal Gold Medal of the Institute—Philip Hardwick, R.A.

A Silver Medal of the Institute—Mr. Edward L. Tarbuck, for his Essay—"An Historical Sketch of the past development of Architecture, considered as a fine art, with an examination into the principles of modern practice, and the present state of the profession."

A Medal of Merit (with an honourable addition thereto)—Mr. C. F. Hayward, for his Essay "On the Pre-Gothic Age in Germany, or the Romanesque development of the Rhine and Central Europe."

Medals of Merit—Mr. J. G. Elgood, for his Essay "On Architecture, its Past, Present and Future;"—and Mr. T. A. Britton, for his "Essay on Timber and Deals, with some remarks on Seasoning and Dry-rot."

A Prize in Books—Mr. F. T. Gomperts, for his "Design for a Metropolitan Railway Station."

The PRESIDENT having congratulated the several candidates who had obtained the Silver Medals and Prizes, said, the next prize is that which the munificence and kindness of our Sovereign authorise me to distribute.—Mr. Hardwick, you will, I am sure, from what you know of me, feel that no part of the duty which devolves upon me from my position in this chair, is more grateful to me than that of being the means, as the interpreter of the feelings and wishes of your professional brethren, of offering you the mark of their respect and admiration which I am now authorised to present to you. You know me well enough to feel that what I say is not a mere compliment. It is not for me, in speaking to a man like yourself, and in such a society as the present, to enumerate the various claims you have on our admiration and approbation. It is not for me, however fond I may be of architecture, and anxious to encourage it,—to set up my opinion; but I think I may honestly appeal to everybody when I say that the prize now in my hand is given to a man who has great talent of invention, and the power of accomplishing many different objects in many different ways. I am one of the Goldsmiths' Company, and therefore have enjoyed many festive meetings in their magnificent hall. I also am occasionally obliged to travel by the railroad; and the young gentleman who has just now received a prize for his suggestions on that subject, has an excellent specimen before him of a man who can form a grand railway station. Again, when we remember by whom the most ornamental and important part of one of the great legal institutions of this country, Lincoln's Inn, was constructed and decorated,—when we recollect that for one of the largest systems of Docks in this country, we are indebted to my friend, and to his energy and capability in satisfying the wishes and wants of a great mercantile people,—I do not believe it is necessary for me to say that he affords an exemplification of what the mind of man can do, devoted to the purposes which his country calls upon him to fulfil; and when his brethren around him pay a tribute to his merits, I think it is indeed well deserved. It is therefore a source of the greatest gratification to me that it has fallen to my lot to be the means on the present occasion. If you were not present I might perhaps say more. I have alluded to the professional and public character of Mr. Hardwick; I might say a great deal more with regard to private circumstances. I might allude to the integrity of his character,—the confidence which has been placed in him by all classes,—the reference to him in cases of arbitration and similar matters. Omitting these, however, I am satisfied, that all who hear me agree with me that the prize which I have now the pleasure of giving, is fully deserved.

Mr. HARDWICK replied,—I believe it is now my pleasing task to thank your Lordship, and you, gentlemen, for having this year selected me to receive this Royal Medal, a selection that may be considered a very proud distinction for the member who receives it. I must, in the first instance, almost before I thank his Lordship for the kind expressions he has used towards me, express on the part of the Institute, our gratitude to our Sovereign for the interest her Majesty has been pleased to show in the Institute by this mark of her Royal favour. Let me also for one moment advert to her Royal Consort, Prince Albert. I believe that through the extreme devotion and attention he has paid to the advancement of art in this country, there is no period that we can look back upon when art was so greatly encouraged as it is in this present moment; and I think, without using too flattering expressions, we may date that encouragement from the time when His Royal Highness first came to this country. Let me now for one moment advert to the expressions with reference to myself which have fallen from His Lordship. They are to me much too flattering. I cannot take the credit to myself of deserving the very kind manner in which His Lordship has brought me to your notice; but this I may say, that having had the honour of enjoying his personal and corteous kindness many years, however great the gratification I feel for this honour, that gratification is very much increased by the mode in which it has been conferred. Gentlemen, however high the reputation of an architect may be in public estimation, I hold that it is equally important that an architect should feel himself placed highly in the estimation of his professional brethren; and it is that very circumstance which increases the gratification of this honour; for Her Majesty with great kindness has allowed the members of the Institute of British Architects to determine among themselves the selection of the member who is to receive it; and I cannot imagine, after a long professional career, a prouder position than that in which I am this night placed. Gentlemen, I feel that another point which affords considerable gratification to the architect of Great Britian who receives this medal is, that it is well known to him that it is not confined to architects of this country; but that Her Majesty has most wisely considered that excellence in art is peculiar to no soil, and that therefore this honour may be participated in by every part of the civilised world. But, my Lord and Gentlemen, I cannot but feel that I owe in some degree the position in which I am now placed to the loss which architecture has just sustained by the death of one of her most distinguished professors; and France must deplore in particular that architect, who, I am sure, would have had this medal, and would most justly have deserved it. With consummate talent he had surmounted the great difficulty of uniting the Louvre and the Tuileries. After having matured and perfected that scheme with the approbation of the Sovereign and the universal consent of the country, he was charged with the completion of that vast work in which so many architects of great celebrity had preceded him. But alas! in the zenith of his high career, M. Visconti was arrested by the hand of death; and it should be a warning to us all, whenever a large work is entrusted to us, not to be too confident that life may be spared to us to witness its completion.

## NEW PATENTS.

### PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAW AMENDMENT ACT.

*Dated October* 17, 1858.

2389. W. Roy, sen., Cross-Athurlie, Renfrew—Improvements in the preparation or thickening of colouring matters for printing

*Dated October* 21.

2434. C. N. Michel and A. Lecomte, Paris—Improvements in windows

*Dated January* 3, 1854.

17. J. Bernard, Regent-street—Improvements in the manufacture of boots and shoes; part of such improvements being applicable to the manufacture of garments

*Dated January* 7.

40. J. Ross, Keighley, York—Improvements in making compounds of chocolate, cocoa, and other ingredients for breakfast and occasional beverages

*Dated January* 21.

145. M. L. L. Beaudeloux, Paris—A self-acting cradle, with improved mattrass.

*Dated January* 23.

159. J. Rowlands, Ladywood-lane, Birmingham — Improved fastening to be used instead of buttons, buckles, clasps, snaps, hook and eyes, and other similar fastenings.

170. P. A. Lecomte de Fontainemoreau, Finsbury—Improvements in the preparation and combination of fatty and resinous bodies, and vegetable and other wax, for the manufacture of candles, also in the preparation of a wick to be used for the same. (A communication)

*Dated February* 2.

262. H. Watson, High-bridge, Newcastle-on-Tyne — Improvements in the working of brass and copper into forms, and planishing them

*Dated February* 3.

267. P. A. Lecomte de Fontainemoreau, Finsbury—Improvements in the construction of buildings. (A communication)

269. C. H. Collette, Lincoln's-inn-fields—Improved method of reducing ores. (A communication)

271. J. Rogerson, S. Rogerson, and J. Rogerson, jun., Manchester—Improvements in machinery or apparatus for embossing, cutting, and perforating textile fabrics

273. W. Longmaid, and J. Longmaid, Beaumont-square—Improvements in the manufacture of vegetable charcoal

275. P. J. Meeus, Paris—Improvements in the manufacture of threads from or with gutta-percha, and in ornamenting the same

*Dated February* 4.

277. G. Mills, Glasgow—Improvements in the construction of steam-vessels, and in steering the same

279. J. Boydell, Anchor Iron Works, Smethwick, near Birmingham—Improvement in the beds of reverberatory furnaces used for puddling iron

281. R. S. Newall, Gateshead, Durham—Improvements in the setting up of ships' rigging

*Dated February* 6.

283. T. Sullivan, Foot's Cray, Kent—Improvements in rollers and moulds used in making paper

285. B. W. Firth, Oldham, Lancaster—Improvements in the method of stopping railway trains, of working breaks on railway and other carriages, and of communicating signals from one part of a railway train to another

287. A. L. N. Comte Vander Meere, Paris—The manufacture of artificial whalebone, or a substance capable of being employed as a substitute for whalebone and tortoise-shell. (A communication)

289. J. B. Graham, Glasgow—Improvements in the production of printing surfaces

291. W. Neilson, Glasgow—Improvements in blowing-engines

*Dated February* 7.

293. J. W. Moseley, Heathfields, Stafford—Improved method of uniting glass and argillaceous cylinders and tubes for conducting water and other fluids

295. J. Elce, Manchester—Improvements in machinery for spinning cotton and other fibrous materials

297. H. Olding, Lambeth—Improvements in stoves and fireplaces

299. A. E. L. Bellford, Castle-street, Holborn—Improvements in the manufacture of artificial stone. (A communication)

301. A. Pope, Edgeware-road — Improvements in machinery for crushing, grinding, amalgamating, and washing quartz or matters containing gold.

303. A. V. Newton, Chancery-lane—Improvements in bleaching textile fabrics. (A communication from J. Lea and A. Roth, Philadelphia, U. S.)

305. B. U. Bianchi, Paris—Improvements in preventing accidents on railways

*Dated February* 8.

307. G. W. Knocker, Bushy Ruff, Kent—New method for producing rotatory motive power by means of water

*Dated February* 9.

308. J. Perry, Leeds—Improved drilling-machine
309. J. Ramsbottom, Longsight, near Manchester — Improved hoist for raising and lowering railway rolling stock and other articles
310. J. Dalton, Hollingworth, Chester—Improvements in the construction of bowls or cylinders employed in printing and other processes; and which improvements may also be adapted to other mechanical appliances
311. H. Moorhouse, Denton, Lancaster—Improvements in part of the machinery or apparatus used in preparing cotton, wool, or other fibrous materials to be spun
312. P. A. Lecomte de Fontainemoreau, Finsbury—Improvements in fire-arms. (A communication)
313. F. Vouillon, Princes-street, Hanover-square—New process of protecting the silvering of looking-glasses. (A communication)
314. J. Samuel, Great George-street, Westminster, and A. W. Mackinnon, New Palace-yard, Westminster—Improvements in drying flax, straw, and other fibrous substances
315. G. Tournay, Newington-causeway—Improvements in obtaining motive power
316. E. Boileau, Holford-place, Clerkenwell—Improvements in producing raised printing surfaces
317. F. M. Lyte, Florian Torquay, Devon—Improvements in apparatus for ascertaining the depth of water
318. P. J. Meeus, Paris—Improved apparatuses for planting grain and seeds, depositing manure, and for performing operations connected therewith. (A communication)

*Dated February* 10.

320. D. Brown, Smethwick, Stafford, and J. Brown, West Bromwich, Stafford—Improvement or improvements in the construction and manufacture of axles for railway and other carriages
321. W. Duck and W. Wilson, London-road, Southwark—An internal gas-heating apparatus
323. S. Hunt and T. Morris, Long Eaton, Derby—Improvements in covering the roofs of buildings with slates, tiles, or other material
324. T. Allcock, Ratcliff-on-Trent, Nottingham—Improvements in machinery for cutting straw and other vegetable substances
325. B. H. Hine and J. A. Mundella, Nottingham, and L. Barton, Hyson-green, Nottingham—Improvements in the manufacture of knitted fabrics
326. J. Young, Glasgow—Improvements in gas-making
327. J. Rives, Hotel Motay, Rue Motay, Paris—Improvements in railways and railway-carriages
328. H. Warner, J. Haywood, and W. Cross, Loughborough—Improvements in knitting machinery
329. J. Johnson, Manchester—Improvements in apparatus to be used for the preservation of life at sea
330. H. Bridges, Bridgewater, Somerset—Improvements in buffers for railway carriages and wagons
331. J. Mitchell, Dyke Head, Lanark—Improvements in forcing or distributing liquids
332. W. Whiteley, Lockwood, near Huddersfield—Improvements in machinery or apparatus for tentering or stretching woollen and other fabrics
333. J. H. Johnson, Lincoln's-inn-fields—Improvements in the manufacture of metallic pens. (A communication)

*Dated February* 11.

334. A. J. B. L. Marcescheau, Paris—Improvements in locomotive engines. (Partly a communication from C. Baron de Berchtold, Vienna)
335. P. Buchan, Peterhead—Improvements in apparatus for measuring and indicating the distances traversed by carriages
336. G. Bird, Glasgow—Improvements in the sub-structures or foundations of buildings
337. J. Jennings, jun., Lorton, Cumberland—Improvements in breaks for railway and other carriages.
338. J. Getty, Liverpool—Improved mode of plating iron vessels
339. J. Rogers, West 21st-street, New York—The preparation of asphaltum, coal tar, resin, resin-oil, naptha, and turpentines, for the manufacture of lamp-black
340. J. F. D. de Bussac, Upper Charlotte-street, Fitzroy-square—Improvements in paving and covering places

*Dated February* 13.

341. G. Ayres, City-road—Improved clip or file, for holding papers or other articles
342. W. Brown, Albany-road, Old Kent-road—Improvements in printing machinery
343. T. Edwards, Broad-street, Birmingham—New or improved fastening for articles of dress
344. A. Chalmers, Dundee—Improvements in mangles
345. D. Campbell, and J. Barlow, Accrington, Lancaster—Improvements in looms
346. E. Clegg and E. Leach, Rochdale—Improvements in slubbing, spinning, drawing, twisting, doubling, and winding wool, cotton, silk, flax, and other fibrous substances
347. J. Cox, Wenlock-road—Improvements in knives for cutting paper and other materials
348. S. R. Brown, Glasgow—Improvements in printing textile fabrics, and other surfaces
349. W. Macnab, Greenock, Renfrew—Improvements in steam-engines
350. J. Greenwood, Irwell Springs, Lancaster—Improvements in dyeing textile materials or fabrics
351. J. B. Smith and E. Smith, Regent-street—Improvements in bonnets
352. A. V. Newton, Chancery-lane—Improved mode of protecting iron from oxidation. (A communication)

*Dated February* 14.

353. T. Bury, W. Glover, J. W. Speed, and J. Hardman, Salford, Lancaster—Improvements in machinery or apparatus for stretching, drying, and finishing yarn and woven fabrics composed of cotton, wool, silk, or other fibrous materials
354. W. Sealing, Old Basford, Nottingham—Improvements in machinery for cutting and ornamenting skeins to be used in the manufacture of baskets and other wicker-work
355. L. Faure, Paris—Improvements in the process for manufacturing iodine
356. C. A. Holm, Cecil-street, Strand—Improvements in propelling
357. T. Irving, Mould Green, near Huddersfield—Improvements in obtaining a metallic and lustry appearance to fabrics and yarns
358. S. Perkes, Walbrook—Improvements in valve-cocks. (A communication)
359. A. Jonson, Mitcham, Surrey—Improvements in preparing barley and grits or groats
360. G. Wilson, Sheffield—Improvement in axle-boxes
361. P. O'Connor, Wavertree, near Liverpool—Improved lever-hinge for suspending and closing doors and gates

*Dated February* 15.

362. J. Hossell, Regent-road, Salford—Improvements in machinery or apparatus for washing, scouring, and squeezing leather, or other similar substances
363. J. Potter, Manchester—Improvement or improvements in machinery for preparing, spinning, and twisting cotton or other fibrous substances; applicable also to machinery for winding threads or yarns of the same
364. W. Asbury, Birmingham—Improvement or improvements in forks for agricultural and other purposes
365. B. H. Hine, A. J. Mundella, and W. Onion, Nottingham—Improvements in machinery for the manufacture of textile and looped fabrics
366. O. Barrett, Wimpole-street—Improvement in the construction of tobacco-pipes
367. T. Jennings, Brown-street, Cork—Improvements in stoppers for bottles
368. J. Wren, Tottenham-court-road—Improved construction of folding-chair bedstead
369. G. F. Wilson, Belmont, Vauxhall—Improvements in preparing an oil, and in the manufacture of candles and night-lights

*Dated February* 16.

370. F. Preston, Manchester—Improvements in flyers for machinery for preparing flax, and certain other fibrous materials
371. C. F. Varley, Charles-street, Somer's-town—New arrangement or apparatus for transmitting electric telegraph signals
372. J. Bush, Derby—Improvements in locks and lock-furniture
373. J. Greenwood, Irwell Springs, Lancaster, and R. Smith, Bacup—Improvements in sizeing, stiffening, and finishing textile materials or fabrics
374. T. Summerfield, Birmingham—The manufacture of chromatic glass and glass-faced bricks, which said bricks are applicable to face-work or fronts of buildings, basements, pilasters, string-courses, door and window heads, medallions, cornices in part or whole, or other purposes where a superior finish and durability are required; a part of which is also applicable to bricks made wholly of clay
375. J. D. M. Stirling, Larches, near Birmingham—Improvements in the manufacture of steel
376. J. Pritchard, Portsea, Hants—Improvements in the construction of screw-propellers, and machinery for driving the same
377. G. F. Wilson, Belmont, Vauxhall—Improvement in the manufacture of lubricating matters

*Dated February* 17.

378. T. Fawcett, jun., Lisburne, Ireland—Improvements in weaving linen or other fabrics to produce plaits or folds therein
379. T. T. Macneill, Mount Pleasant, Ireland—Improvements in drying flax, straw, and other organic substances
380. A. Ford, Lowndes-street, Belgrave-square — Improvements in manufacturing varnish
381. H. Ross, Nottingham—Improvements in machinery for the manufacture of textile and looped fabrics
382. W. Wright, Wolverhampton—Improvements in ornamenting walls and other similar surfaces
383. G. Smith, jun., Belfast—Improved machinery for retarding and stopping railway carriages
384. G. Wethered, Maidenhead, Berks—Improvements in machinery or apparatus for shaking straw
385. J. Hinchcliffe, jun., Dam Side, York—Improvements in metallic pistons for tightening or adjusting the packing of the same, and also improvements in the construction of such pistons. (A communication)
386. R. Holt, Shaw, Lancaster—Improvements in machinery or apparatus for manufacturing bricks and tiles
387. E. Rowland and J. Rowland, Wakefield-street, Manchester—Improvements in cleaning the tubular flues of steam-boilers
388. M. Poole, Avenue-road, Regent's-park—Improvement in boiler-furnaces and other furnaces. (A communication)

*Dated February* 18.

389. P. G. Harris, Buckingham-street, Adelphi—Improvements in locomotive engines. (A communication)
390. W. Morrison, Bowling, Dumbarton—Improvements in railway-wheels
391. J. C. Nesbit, Chemical and Agricultural College, Lower Kennington-lane—Improvements in the manufacture of manure
392. B. W. Wells, Windmill-lane, Camberwell—Improvements in printing floor and other cloths
393. E. Loysel, Rue de Gretry, Paris — Improvements in apparatus for obtaining infusions or extracts from various substances
394. B. Britten, Annerley, Surrey—Improvements in crushing, pulverising, and washing mineral earths or ores, and amalgamating the gold and silver contained therein; which said improvements are also applicable to crushing and pulverising other substances

*Dated February* 20.

395. J. R. Hill, Princes-street, Lambeth—Improvements in machinery for pulverising metallic ores, or other similarly hard substances
396. N. Riggenbach, Basle, Switzerland—Apparatus for preventing incrustation in steam-boilers.
397. W. H. Barlow, Derby—Improvements in securing and connecting the rails of railways
398. J. Aspinall, King William-street—Improvement in machinery employed in the manufacture of sugar
400. T. Gray, St. Clement's-lane, Strand—Improvements in the manufacture of pulp from wood
401. J. Chisholm, Holloway—Improvements in the purification of gas
402. J. Beall, Effingham-place, Herts — Improvements in apparatus for suspending looking-glasses in frames
403. H. Hilliard, Glasgow—Improvements in apparatus for cleaning and sharpening table cutlery
404. T. Towers, Salford, Lancaster—Improvements in marking-boards used in connection with billiard and bagatelle tables, for registering and indicating the number of games played
405. W. Milner, Liverpool—Improvements in locks for safes; which said improvements are applicable to locks in general
407. J. Urie, Glasgow—Improvements in photographic pictures

*Dated February* 21.

408. J. Ramsbottom, Longsight, Manchester—Improvements in welding
409. F. Osbourn, Aldersgate-street—Improvements applicable to the cutting out of garments
410. H. King, Gilbert-street, Oxford-street—Improved mode of signalising between the guard and driver of a railway train
411. J. Gedge, Wellington-street South—Improvements in the construction or adaptation of certain fittings for gas. (A communication)
412. V. Pernollet, Broad-street, Golden-square—Improvements in machinery or apparatus for sorting or separating wheat and other grain from different kinds of grain, and for separating or removing extraneous matters from wheat and other grain
413. S. T. Jones, Union-court, Old Broad-street—Improvements to reduce and wash minerals to extract metal therefrom, especially gold
414. R. Walker, Glasgow—Improvements in signalling by voltaic electricity, for the purpose of increasing the safety of railways
415. J. Boydell, Gloucester-crescent, Regent's-park—Improvement in the manufacture of hurdles and gates
416. E. Gessner, Ane, Saxony—Improvements in gig-mills
417. J. Smith, Glasgow—Improvements in ornamental weaving
418. J. H. Johnson, Lincoln's-inn-fields — Improvements in machinery for making matches. (A communication from E. Zulser, New York)
419. A. Dixon, Smethwick, Stafford—Improvements in railway axle-boxes and bearing-springs
420. A. Dixon, Smethwick, Stafford—Improvements in timber scaffolding or stageing
421. A. B. Baron Von Rathen, Wells-street—Improvements in omnibuses, for the purpose of adapting them to be drawn by one horse, and to be attended by one man only

422. W. Gossage, Widnes, Lancaster—Improvements in the manufacture of certain alkaline carbonates, and in the useful application of such carbonates
423. W. C. T. Schaeffer, Stanhope-terrace, Hyde-park-gardens—Improved mode of recovering the fatty matters contained in waste waters of woollen mills

*Dated February* 22.

424. W. E. Newton, Chancery-lane—Improvements in fire-arms and in projectiles. (A communication)
425. J. Morison, Paisley, Renfrew—Improvements in celestial and terrestrial globes
426. E. Taylor, Kinghorn, Fife—Improvements in gill-heckles or combs for treating fibrous materials
427. D. Assanti, Upper Berkeley-street—Means of rendering porous substances waterproof
428. E. Massey, Tysoe-street, Clerkenwell—Improvements in ships' logs, known as "Massey's Patent Ships' Logs"
429. S. Colt, Spring-gardens—Improved machinery for rifling fire-arms. (Partly a communication)
430. J. de Wolfe Spurr, Kenyon-terrace, Birkenhead—Improvements in distilling coals and bituminous and resinous substances and products thereof
431. J. Boydell, Gloucester-crescent, Regent's-park—Improvements in applying apparatus to carriages to facilitate the draft

*Dated February* 23.

432. T. Settle and P. Cooper, Bolton-le-Moors, Lancaster—Improvements in machinery or apparatus for preparing, slubbing, and roving cotton and other fibrous materials
433. A. Oppenheimer, Manchester—Improvements in the manufacture of mohair velvet or mohair plush
434. T. Robinson, St. Helen's, Lancaster—Improvements in machinery or apparatus for raising and lowering goods
435. J. Barling, High-street, Maidstone—Improvements in treating the hop-bine, and rendering it applicable to the manufacture of paper and other articles
437. T. D. Pruday, Rupert-street, Haymarket—Improved apparatus for cooling liquids and edible substances
438. W. Hunt, Lea Brook Chemical Works, near Wednesbury—Improvements applicable to the utilising of ammonia given off in certain manufacturing processes
439. H. Stoy, St. John's-road, Battersea—Stopping of engines and carriages on railways, and also vehicles of every description on the common roads
440. E. Foard, Nicholas-street, New North-road—Improvements in furnaces

*Dated February* 25.

441. P. Fairbairn, Leeds—Improvements in machinery for winding slivers of flax, tow, or other vegetable fibrous materials into laps or balls
442. W. Ryder and J. Ryder, Bolton-le-Moors, Lancaster—Improved composition applicable to coating metals
443. E. Kingsbury, Knightsbridge—Improvements in apparatus for indicating the rise or fall of water or other liquids in ships' holds, tidal harbours, or other vessels or places
444. S. L. Hardy, Dublin—Improved apparatus for applying chloroform vapour or other similar vapour in certain cases
446. C. Cowper, Southampton-buildings—Improvements in furnaces. (A communication from L. Laureau, Paris)
447. C. Cowper, Southampton-buildings—Improvements in the manufacture of potash and soda. (A communication from L. Laureau, Paris)
448. J. Banfield, Birmingham—Improvements in apparatus for communicating (while riding) with the drivers or guards of public or private vehicles
451. C. J. Fisher, Temple—Improved means of detecting forged or counterfeit bank-notes, bills of exchange, cheques, or other documents, labels, or trade-marks
452. E. H. Bentall, Heybridge, Essex—Improvements in ploughs or implements for cultivating land
453. E. Power and T. Knowles, Birmingham—Improvements in watches, spring-clocks, and time-pieces
454. T. Forsyth, Wolverton, Buckingham—Improvements in furnaces
455. A. E. L. Bellford, Castle-street, Holborn—Improvements in machinery for dressing stone. (A communication)
457. A. E. L. Bellford, Castle-street, Holborn—Improvements in engines for generating power by means of the expansive force derived from heated air and gases, or by means of the expansive force of liquid carbonic acid and other expansible liquids. (A communication)
458. J. Barker, J. Andrew, and W. Hayes, Salford, Lancaster — Improvements in cleansing sheep's wool, mohair, and other animal fibrous substances
459. C. W. Siemens, Adelphi Chambers—Improvements in electric telegraphs. (Partly a communication)
461. G. Collier, Halifax, York—Improvements in twisting fringes of shawl and other fabrics
462. J. Keenan, Paris—Improvements in forming blocks or surfaces for printing. (A communication)
463. C. F. Bekaert, Rue de la Victoire, Paris—Improvements in linseed-oil for painting, called "Oxigenated Oil." (A communication)
464. C. Lamport, Workington—Improvements in machinery used in shipbuilding
465. J. Boydell, Gloucester-crescent, Regent's-park—Improvements in the manufacture of hurdles and fences
466. J. Elder, Glasgow—Improvements in marine steam engines
467. A. Plantin, Thayer-street, Manchester-square—Improvements in the arrangement and combination of apparatus for stopping and retarding railway trains and carriages
468. W. E. Staite, Manchester—Improvements in the treatment and preparation of madder and munjeet for dyeing and printing
469. F. Westbrook, Kensington—Improvements in apparatus for facilitating the cleaning of windows

*Dated February* 27.

471. P. Fougerat, Bordeaux, France—Improvements in paddle-wheels of steam-vessels
472. J. D. M. Stirling, Larches, near Birmingham—Improvements in the manufacture of tubes and cylinders of steel
473. C. de Bussy, Mornington-road, Regent's-park—Improvements in machinery or apparatus for the amalgamation of gold ores
474. J. H. Johnson, Lincoln's-inn-fields—Improvements in harrows. (A communication)
476. J. Morrell, Bradford, York—Stopping the tap of any vessel containing oil, treacle, or any other liquid, as soon as the quantity required of such oil, treacle, or other liquid has been taken therefrom, such quantity being ascertained by weight

*Dated February* 28.

477. L. A. Pallegoix and A. L. Bellange, Paris—Improvements in treating wheat and other grain
479. F. S. Thomas, Cornhill—New rifle carriage
480. E. Marsden and J. Marsden, Liverpool—Improvements in pumps
481. A. E. L. Bellford, Castle-street, Holborn—Improvements in the means of admitting the steam or other motive-power agent to and exhausting it from the cylinders of oscillating engines. (A communication)
482. J. H. Rebe, Bayswater—Improvements in machinery or apparatus for mixing, washing, crushing, bruising, reducing, or comminuting various substances
484. C. Mather, Salford Iron Works, Manchester—Improvements in valves for reducing the pressure of steam
485. A. L. Mallet, Rue de la Pepinère, Paris—Improvements in apparatus to destroy the effects of shocks
486. W. Patten. Old Fish-street—Improvements in valves and apparatus for supplying water
487. J. Medwin, Blackfriars-road—Improvement in water-gauges for steam-boilers
488. E. C. Shepard, Trafalgar-square—Improvements in decomposing water by electric currents. (A communication)
489. J. T. Way, Holles-street, and J. M. Paine, Farnham—Improvement in the manufacture of gas, and also of a charred product
490. T. J. Johnson, Booth-street, Spitalfields—Improvements in apparatus for roasting malt
491. J. S. Holbeche, Sutton Coldfield, Warwick—Improvements in the construction of invalid bedsteads; which said improvements are also applicable for couches, chairs, and reclining seats or beds for invalid carriages
492. J. H. Johnson, Lincoln's-inn-fields — Improved apparatus for facilitating the acquirement of the art of reading. (A communication from N. Chéron and F. N. Tallempin, Paris)

*Dated March* 1.

493. H. Gilbert, Suffolk-street, Pall-Mall—Improvements in connecting and supporting artificial teeth
494. J. T. Cortin, New Compton-street, Soho-square—Soleing shoes and boots with leather combined with gutta-percha and wood, sewed with metallic wire
495. W. Ehrhardt, Birmingham—Improvements in the construction of ordnance and fire-arms, and in loading the same
496. C. Hargrove, Birmingham—Improvement or improvements in steam-boiler and other furnaces
497. W. J. Curtis, Birchin-lane—Improved levigating machine
498. T. H. Ewbank, South-square, Gray's-inn—Improvements in the manufacture of terry or looped fabrics, and in machinery for producing the same
501. J. Sibley and T. Sibley, Ashton-under-Lyne, Lancaster—Improvements in machinery or apparatus for cutting discs or circles out of plates or sheets of metal or other substances
502. W. and J. Clibran, Manchester—Improvements in apparatus for regulating or governing the supply or pressure of gas as it is conducted from the main to the burners
503. M. N. Illakowicz, Maddox-street—Improvements in picture-frames
505. J. S. Holland, Woolwich, Kent—Improvements in locks
506. T. Metcalfe, High-street, Camden-town—Improvements in the manufacture of portable and folding bedsteads, chairs, seats, tables, and cots

*Dated March* 2.

507. J. Parry, jun., Liverpool—Improvements in mills or machinery for grinding or cutting bones, wood, or other like substances. (A communication)
508. R. V. Houssart, Dunstan-street, Kingsland-road, and R. Houston, Skinner-street, Snow-hill—Improvements in vessels to contain fluids
509. H. Ellis and J. Ellis, Salford, Lancaster—Improvements in machinery or apparatus for stretching and finishing woven fabrics
510. A. Barclay, Kilmarnock, Ayr—Improvements in lubricating shafts and revolving metallic surfaces
511. A. Barclay, Kilmarnock, Ayr—Improvements in arranging and working mining engines and machinery
512. J. Currie, Glasgow—Improvements in the treatment and grinding of grain, and the products thereof
513. T. Dawson, King's Arm's-yard—Improvements in umbrellas and parasols
514. J. Taun, Minerva-terrace, Hackney-road—Improvements in the construction of locks

*Dated March* 3.

516. T. Yates and R. Yates, Bury, Lancaster—Improvements in looms
518. L. Tindall, Scarborough, York—Improvements in churns
520. G. Spill, Old Farm House, Stepney—Improvements in the application of waterproof hat-bands to the manufacture of hats.
521. W. E. Newton, Chancery-lane—Improved machinery for measuring and folding cloth and other fabrics, or manufactured materials. (A communication)
522. C. Bloomer, West Bromwich, Stafford—Improvements in spikes and bolts
523. J. Bour, Mauritius—Improvements in evaporating saccharine liquids
524. W. Vaughan, Stockport, Chester, and J. Scattergood, Heaton Norris, Lancaster—Improvements in machinery, apparatus, or implements for weaving

*Dated March* 4.

526. C. Nightingale, Wardour-street, Soho—Improvements in the mode of curling horsehair and other materials
528. R. Madeley, Birmingham—Improvement or improvements in the joints and framing of metallic and other bedsteads, chairs, sofas, couches, and such other articles as are or may be used for sitting, lying, and reclining upon
530. H. D. Mertens, Margate, Kent—Improvements in working steam-engine valves. (A communication)
532. J. K. Stuart, Glasgow—Improvements in hats and other coverings for the head

*Dated March* 6.

534. J. Warhurst, Hollingworth, Chester—Improvements in steam-boilers
538. T. H. de Nivelles, Foley-place—Apparatus for separating metallic from earthy and other substances, and for classifying metallic substances according to their specific gravities
540. P. A. de St. Simon Sicard, Paris—Improvements in purifying sea and other water
542. B. Brokenshar, St. Austell, Cornwall—Improved amalgamator

*Dated March* 7.

544. W. Clay, Liverpool—Improved mode of manufacturing axles, shafting, and other like solid articles which present a round figure in cross section
546. G. Chant, Stoke-sub-Hamdon, Somerset—Fan-parasol, or sun-shade

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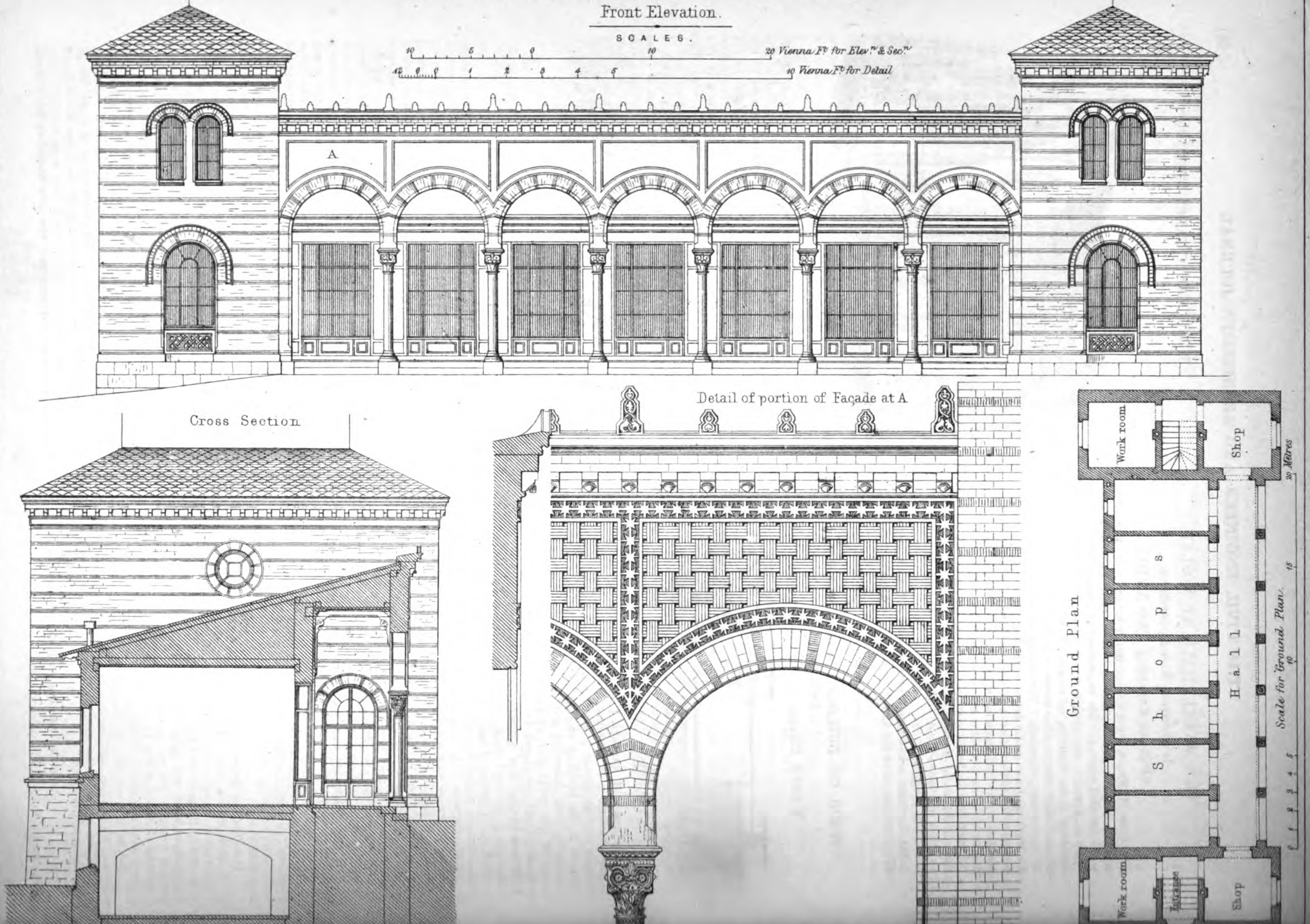
PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

460. F. W. A. de Fabeck, Norfolk-street, Strand—Construction of bridges, viaducts, lintels, beams, girders, and other horizontal structures and supports.—Feb. 25
504. T. Truscott and T. P. Baker, Naval Engineers' Club, Portsea, Hants—Improved arrangement of steam-engines adapted to screw propulsion.—March 1
515. W. Brown, Glasgow—Improved mode of obtaining voltaic products from bituminous coal and other bituminous substances.—March 3
519. J. Nicholson, Dublin—Improvements in and applicable to certain descriptions of close kitchen-ranges.—March 3
571. S. Trotman, Portman-square—Improved alarum night-clock or time-indicator.—March 9
585. G. Appolt, Sulzbach, Prussia, and C. Appolt, Metz, France—Improvement in the manufacture of coke.—March 10

MARKET HOUSE AT VŒSLAU NEAR VIENNA.



## THE MARKET-HALL AT VOSLAU.

L. Forster, Vienna, *Architect.*

(*With an Engraving, Plate* XVIII.)

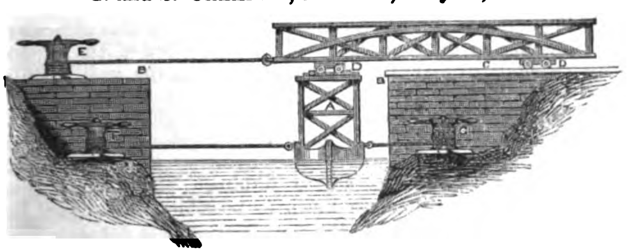
Count M. Fries, a gentleman much attached to the arts, has erected a small market-hall at Voslau, near Vienna, a watering place for that capital. He intrusted the design and execution to Herr L. Forster, the architect, of Vienna. The object of this building is to combine, by means of the pillared hall, the wants of the traders during the summer months with the requirements of the bathing visitants. The basement serves as a store-cellar for fruit, and the levels are so arranged that a union is effected between the place or area of the market-hall and the large space planted with fruit trees belonging to the garden of the Count's mansion. The pavilions are occupied as dwellings.

The columns, bases, cornices, and acroteria are of sandstone, and all the walls of well-burnt yellow tiles, among which rows of red tiles are introduced. The ornaments are from the clay-ware factory at Wagram.

Mr. L. Forster has lately constructed a new bridge over the Wien stream, near the Carinthian Gate at Vienna.

## MODE OF BUILDING AND TRANSPORTING BRIDGES.*

T. and S. Champion, *Patentees*, May 22, 1853.



The annexed engraving is a side view or elevation of an improved mode of building bridges on the land, and conveying them to their places over streams. The principal feature in this mode is, the building of the bridge on the land, at about the level with its intended position, on a prepared roadway C, on one of the previously prepared abutments B, B, on which the trucks D, D, are placed for the land part of the transportation. Which having been accomplished, a vessel or vessels of sufficient buoyancy for the burden to be imposed, having upon it a frame work A, of proper height, is floated by the stream either under the already projecting end of the bridge, or against the abutment, for the purpose of having the bridge rolled upon it. The vessel being provided with a valve to receive, and a pump to discharge water, it may be ballasted therewith, and its buoyancy regulated as desired; after which, all things being in readiness, by means of the capstans F, G, with the ropes attached, the vessel and bridge upon it may be speedily and safely drawn over its place, and lowered to its proper position, by letting water into the vessel, or by jack-screws or other process.

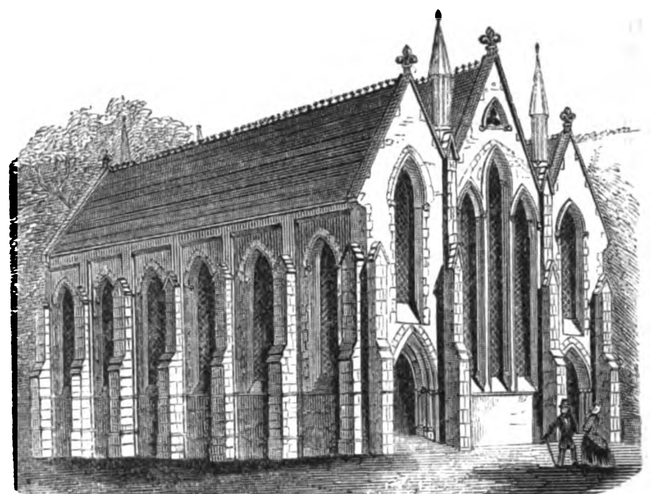
It is claimed for this mode, that a great saving is effected thereby, over the old mode of timber supports from the bed of the stream, even where such supports are practicable, but where the streams are deep, the currents rapid, and the bridge high above the water, such supports are always dangerous, liable to be carried away with freshets, and in some cases positively impracticable.

It is further claimed that the advantages are equally in favour of this mode, over that adopted in placing the celebrated Britannia Tubular Bridge over the Menai Straits, as it is nearly if not quite as convenient and safe to build the bridge at once at the right as at any other height, while it is much easier and safer to move the whole affair on a level, or inclined properly prepared road and flotilla, than to raise the whole weight by any process perpendicularly to its place.

By this mode all the danger incident to working over the water, all the cost and danger of raising such heavy structures from the water, is avoided, by means as simple and safe as they are beautifully effective.

* From the 'Journal of the Franklin Institute.'

## WESLEYAN CHAPEL, TORQUAY.



The annexed woodcut represents a perspective view of a Wesleyan chapel, recently erected at Torquay, of which Mr. E. Appleton was the architect, and Messrs Harvey and Henley the builders. It is capable of holding five hundred persons on the ground (there being no galleries). The internal dimensions are 66 feet by 41 feet. The roofs are open, with arched principals to the nave, supported upon bosses. Each pair of rafters in the aisle roofs intersect one another in the manner of struts. The fittings are of deal, stained and varnished; the pews have trefoil bench-ends. The pulpit is octagonal, buttressed and approached by a double staircase. The communion railing is formed of ornamental scrolled wrought-iron, as also the pulpit stair-rails. An organ of suitable design, by Dickes of Exeter, has been since added. The building is divided by two arcades of six bays, and stands at a considerable elevation above the road, upon a sudden incline under the cliff. Though simple in design, it is highly creditable to the architectural taste of Mr. Appleton.

## EXTENSION OF THE UNITED STATES CAPITOL, WASHINGTON.

The prosecution of the works at the Washington Capitol having been transferred, by order of the President, from the Department of the Interior to the War Department, the Hon. Jefferson Davis, Secretary-at-War, deputed Capt. M. C. Meigs, of the Corps of Engineers, to the special charge and direction of the works, which, under his supervision, have progressed in a manner highly creditable, alike to the liberality of the American legislature and the reputation of those to whom they have been intrusted. On examination of the reports from various officials employed in the erection of this structure, it is particularly observable that proper provisions for the effectual warming and ventilation, as well as the best means for ensuring an equal dissemination of the voice of speakers, have been made during the progress of the works; and not, as is too often the case in our own country, left until after the completion of the building, when alterations are objectionable, not only from their inconvenience and expense, but from the apparatus, &c. involved in these matters being so frequently unsightly and out of all character with the architectural design of the structure wherein they are placed.

The lamentable effects of the want of this foresight in the proper authorities are painfully conspicuous in most of the halls and public buildings hitherto erected; but we trust that the day has arrived when as much scientific investigation and skill will be bestowed upon these all-important particulars as upon the more captivating study of the peculiar style and architectural detail of our churches and national erections. The results of the experiments and observations of Capt. Meigs, in connection with the interior arrangements of the Washington Capitol, will be found to contain much that is exceedingly valuable and universally applicable. We give therefore his "Notes on Acoustics and Ventilation with reference to the New Halls of Congress."

These Notes were submitted to the consideration of Messrs. A. D. Bache, LL.D., and J. Henry, LL.D., who fully corroborated the principles laid down by Capt. Meigs, and approved of their judicious application. The above gentlemen visited many of the most important buildings in Philadelphia, New York, and Boston, for the purpose of examining them in reference to their acoustic qualities, which examination completely established the accuracy of the observations of Capt. Meigs.

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*Notes on Acoustics and Ventilation, with reference to the new Halls of Congress, by Capt.* M. C. Meigs, *United States Corps of Engineers, May* 1853.

Experience shows that the human voice, under favourable circumstances, is capable of filling a larger space than was ever probably inclosed within the walls of a single room. Herschel, in his admirable treatise on sound, gives a few instances which are instructive. Lieut. Foster, on Parry's third Arctic expedition, found that he could converse with a man across the harbour of Port Bowen, a distance of 6696 feet, or about one and a-quarter mile. Dr. Young records, that at Gibraltar the human voice has been heard at a distance of ten miles. I have myself, on the shore of Lake Champlain, at evening, heard the echo of the voice returned from the opposite shore, at a distance of nearly two miles, the sound having travelled between three and four miles before it returned to the ear. If sound be prevented from spreading, and losing itself in the air, either by a pipe or an extensive flat surface, as a wall or still water, it may be conveyed to a great distance. Biot heard a flute clearly through a tube of cast-iron (the water-pipes of Paris) 3120 feet long. The lowest whisper was distinctly heard. In fact, the only way not to be heard was not to speak at all. Standing on the platform used by the painters in the new Congressional Library, Professor Henry and myself conversed in a low tone, hearing distinctly from one end of the room to the other. The room is 99 feet long. The platform is about 7½ feet below the deeply-moulded iron ceiling. Professor Reid states, in describing his lecture and practical class-rooms, which together occupied a space of about 80 feet square, that in every part, both of the lecture-room and of the practical class-room, whether crowded or empty, the slightest whisper or the loudest noise was heard distinctly, without offensive reverberation, or the necessity of any exertion of the voice beyond that used in conversation.

The favourable circumstances seem to be a perfectly tranquil and uniformly dense atmosphere, absence of all extraneous sounds, absence of echoes and reverberation, vicinity of reflecting surfaces, and perhaps in some measure the presence of substances which conduct sound well. A pure atmosphere being favourable to the speaker's health and strength, will give him greater power of voice and more endurance; thus indirectly improving the hearing by strengthening the source of sound, and also by enabling the hearer to give his attention for a longer period unfatigued. The analogy between sound and light in regard to their progress, reflection, and refraction, seems well established. By employing reflectors of proper forms, sound emanating from one point can be collected to a focus at another. When the reflector is a plane surface, the angle of reflection is equal to the angle of incidence. Experiments under water show, that in passing from a denser to a rarer medium, there is an angle of total reflection. The speed of its transmission varies with the elasticity and density of the medium; like light, it is confused by passing through air unequally rarified by heat. It is more difficult to trace the progress of sound than of light. Sound is invisible during its passage, and cannot be traced as light is, by illuminating the motes in its path; nor is the ear as accurate in estimating the direction from which it receives sound, as the eye is in determining the direction of the source of the light which falls upon it. But finding a strong analogy to light in those cases where it can be followed, we may reasonably, within proper limits, infer it in others. The effect of echoes in a small room is generally unnoticed; the echo returns so quickly that the ear receives it as coincident with the original sound, to which it in that case merely adds strength, perhaps prolonging it very slightly. If the room be larger, and the echoing wall so distant that the interval is sensible, the echo makes confusion. If on a calm day we advance towards a wall, producing at each step some sound, we will find a point at which the echo ceases to be distinguishable from the original sound. The distance from the wall or the corresponding interval of time, has been called by Professor Henry the limit of perceptibility. This limit will vary with the nature of the sound; if the sound be sharp and distinct, as that produced by striking some hard substance, we shall find the limit of perceptibility less than for the more prolonged sound produced by the voice. The limit will probably vary also with the acuteness of the ear; some persons being probably able to separate sounds undistinguishable to others. The general limit is probably about 30 or 35 feet. It should be ascertained exactly, and in constructing a room for public speaking the height of the ceiling should not exceed this limit. The sound will then be strengthened to the speaker himself by the echo. The interval between the original and reflected sounds will be shorter for all his hearers than for himself, as twice the path of the voice and echo for the speaker is considerably longer than the difference between the paths of the direct and reflected sounds of one of the auditors. The direct echo from the ceiling then becomes an advantage, by strengthening without confusing the sound. But echo acts in still another way by being repeated between opposite surfaces. The effect is like the multiplication of the image of a candle between two opposite and parallel mirrors. I have noticed it in the long, unfinished room of the Smithsonian, where the sound produced by clapping the hands is repeated so as to resemble a laugh—ha! ha! ha! In this case the distance between the end walls is such as to separate the successive echoes; but when the walls are nearer, the sound becomes contiguous, and is the ringing sound often produced in speaking in empty rooms, and called reverberation. This might trouble us between the ceiling and floor of our room; but a thick carpet absorbing sound and not reflecting it will remove this difficulty. The great size of the room needed for the meeting of the House of Representatives makes it impossible to bring the walls within the limit of perceptibility. Professor Reid proposed in the Houses of Parliament to make the ceiling high in the centre, declining towards the sides, with floors and galleries rising from the centre towards the walls, thus reducing the height and surface of the walls, so as to diminish the quantity of sound reflected from them as much as possible. All regard for architectural beauty forbids the adoption of this construction, which seems to have been modelled upon an empty tortoise-shell. Breaking the walls into deep panels has also been proposed. But when we recur to the limit of perceptibility, we shall perceive that a panel or recess must be over 30 feet deep to separate the echoes from the bottom of the recess and from the face of the wall. The surfaces of mountains covered with trees and rocks return echoes. No wall of an inhabited apartment can be made rougher than these natural reflectors. A simpler and more effectual method of controlling the echoes from the walls will be to cover them with drapery absorbent of sound. The echoes from the ceiling are thus turned to account, and those from the floor and walls guarded against; but the echoes from small objects and surfaces may still be troublesome unless provided for. The trunks of trees in the edge of a forest return together a distinct echo. The beams under the flooring of the Menai Suspension Bridge are instanced by Herschel as giving a curious echo; and even such small objects as the vertical iron rods composing the fence on Pennsylvania Avenue, in front of the President's house, will be found to return a singular whistling echo to the sound made by striking a smart blow upon the pavement on a still night. To guard against this, it will be sufficient to cushion the chairs and cover the desks with some material which will not reflect sound. This may seem, and may possibly be, an unnecessary precaution; but I wish to leave no possible cause of confusion unnoticed, and to point out what I consider the means to obtain, for the first time, a room perfect in its acoustic arrangements.

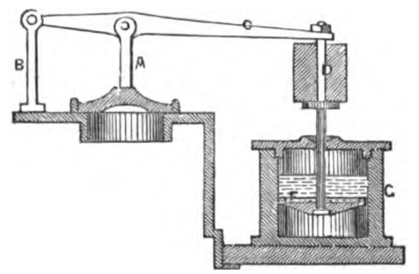
Having thus disposed of the question of echoes and reverberations, the next essentials to perfect and distinct hearing are a tranquil atmosphere and the absence of extraneous sounds. I consider them together, as we shall find that the precautions essential to obtain the one will also secure the other. Windows, in cold weather, separating the warm air within from the cold air without, serve as refrigerators, cooling the air in contact with the glass. The air, thus rendered heavier, immediately falls, and a descending sheet of cold air is produced, which, on reaching the floor spreads over it in a cold stratum, and to persons of sensitive nerves or feeble health causes great inconvenience, being felt as a draught upon the feet and legs. And many an unfortunate page has been blamed for leaving open a door, when the draught really has been caused by this air cooled by the closed glass of an adjacent window. The circulation thus produced of air of different densities is unfavourable to distinctness of hearing. As the ascending hot air along a stove-pipe or heated wall causes irregular refraction of light, and produces a tremulous appearance in all objects viewed through it, so sound, irregularly refracted, becomes less clear and distinct. If we exclude external windows, and light the room only from the roof, we get rid of this fruitful source of discomfort and indistinctness; at the same time, we obtain a pleasanter light, ample for all useful purposes, as is proved by its adoption in all the best constructed picture-galleries. We also exclude the sounds of the exterior, which, saturating the air as it were, distract the attention, and even overpower the voice we wish to hear, as the diffused light of day causes the stars to disappear. Open windows for hearing will be worse than closed ones; they not only let irregular, disturbing currents of air in, but they let the voice out—acting like black spaces in the wall of a room, which do not return the light which falls upon them. The common mode of warming and ventilating public rooms is fatal to perfection of hearing. One or several columns of intensely-heated air are introduced through holes in the floor. Being much warmer than the air of the apartment, they immediately rise to the ceiling. If the exit-apertures for foul air are above, this fresh and heated air alone escapes, having done nothing for the apartment except to cause whirls and currents, such as we see in a column of smoke passing from a chimney on a calm day. The irregular refraction of sound through these currents of unequal density tends greatly to produce confusion. If the exits for foul air are below, the hot air accumulates at the top of the room, and gradually displacing the cooler air, forces it out through these passages. Professor Reid relates that he has found the air near the ceiling of a room at the boiling temperature, while those on the floor were complaining of cold. Here we have strata of different densities and unequal refractive power, and hence confusion of sound. As the warm air must ascend to the top of the room, I propose to let it do so in a large trunk outside of the apartment—pass into a space above the ceiling, and thence by numerous holes find its way, as through a sieve, into the room. By a steam-driven fan, or other mechanical means, we can pump air, in any desired quantity, into any spot to which we choose to direct it. I would drive all the air required for the supply of the room through a maze of hot-water pipes, raising the whole of it to the temperature desired—60° or 80°, as the case might be. If the room be 30 feet in height, and it be desired to change all the air in it every fifteen minutes, enough air should be pumped in above to cause a general descent of the whole body of air in the room at the rate of 2 feet a minute. This would be an imperceptible current. The exit should be made by numerous holes in the floor, perhaps through the carpet, or the risers of the platform on which are the members' chairs. Three important advantages would thus be gained: the avoidance of all eddies, a nearly homogeneous and tranquil atmosphere, and the immediate removal downwards of any dust from the carpet, which would thus be prevented from rising, to be inhaled into the lungs. To prevent the disturbance and contamination of the atmosphere, by the gas-lights, I would place them above the glass of the sky-lights—the space between those in the ceiling and those in the roof being separated from the chamber into which the fresh air should be admitted. In summer, the same apparatus which sends in warm air in winter would supply a constant breeze, and if the temperature of the external air was too high, it might be cooled by jets of water from pipes in the air-passages, or even by melting ice.

To recapitulate, then, I propose to place the ceiling at such a height as to be within the limit of perceptibility, and thus strengthen the voice; to destroy reverberation between the ceiling and the floor, by a thick carpet on the latter; to prevent echoes from the walls, by drapery; from the chairs and desks by cushioning or covering them; to keep out extraneous sounds, by making the room an interior apartment lighted only from above; to secure a tranquil atmosphere, uniform in its density and refraction of sound, by excluding all currents of hot or cold air; to secure a constant supply of pure air at the temperature desired for the room, by mechanical means introducing the air through all parts of the ceiling, and taking it out through all parts of the floor—thus also to remove dust; to prevent all interference with ventilation by the lights at night, by placing them outside the room above the sky-lights.

## SAFETY-VALVES.

H. Waterman, U.S., *Patentee*, November 15, 1853.

The object of this invention is to attain as near as possible a constant and uniform pressure upon the valve; and in order to prevent the vibrations of the weight and lever. A and B, are standards supporting the valve lever C, to the outer end of which is applied a weighted-rod D, connected to a valve F, freely moving in a cylinder G, filled with a fluid to nearly its top. By this means the piston can move no faster than the fluid is made to pass by the piston, and thereby to check sudden vibrations.




*Claim.*—The piston F, attached to the weighted end of the valve-lever within the cylinder G, and immersed in the liquid in the cylinder, combined and operating in the manner and for the purposes herein described.

## REVIEWS.

*Practical Remarks on the Warming, Ventilation, and Humidity of Rooms.* By Francis Lloyd. London: Cox, King-street, Covent-garden. 1854.

This exceedingly clear and common-sense pamphlet should be attentively perused by all classes of society, containing as it does so many practical remedies, within the reach of all, for most of the evils attendant on bad ventilation and imperfect warming of dwellinghouses of all descriptions. Dependent as we are upon the purity and proper degree of humidity of the atmosphere we inhale, it is remarkable that the knowledge of the right means of attaining these essentials is possessed by so few. Until we have purified, and precautions are taken to get rid of the noxious exhalations from, our dwellinghouses, the external atmosphere can never be other than foul. Numberless works are published, and patents secured every year, in connection with ventilation, heating, and improving our sanitary condition; yet the propositions and remedies contained in them are either too complex and expensive, or based upon fallacious principles, or they are crude and impracticable, and but half meet the requirements of the case. In the little work of Mr. Lloyd, the subject is treated in a very explicit and practical manner; the contrivances suggested have been submitted to the test of experiment; they are cheap, simple, and founded in strict accordance with scientific laws.

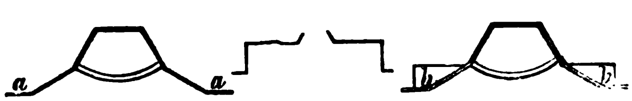
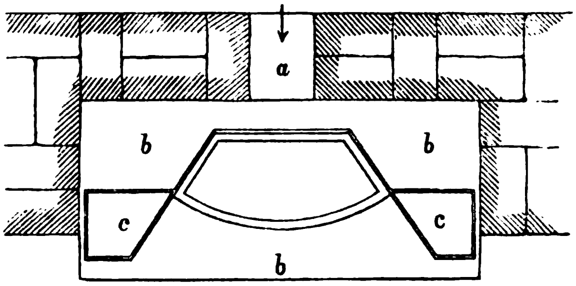



Fig. 1. Fig. 2.

The imperfections of most of the systems of warming are so generally admitted, that we shall refrain from alluding to them here, and pass at once to a simple arrangement for warming proposed and tried by Mr. Lloyd in an old and indifferently built house. The existing stove was removed, and the one shown in plan in fig. 1, substituted, to the cheeks and back of the face *a*, *a*, of which were riveted two strips of sheet-iron, bent so as to fit the stove, as seen in fig. 2, and forming two side chambers or flues *b*, *b*; these flues were connected at top with a horizontal rectangular chamber, having a longitudinal opening towards the apartment, immediately under the mantelpiece. The lower ends of the flue *b*, *b*, were passed into a chamber formed beneath the hearth-plate, which communicated, by means of zinc tube, with the external atmosphere. A passage-way of 36 inches area was thus obtained beneath, around, and above the front part of the stove, providing ingress for pure air from the garden, and egress from the upper part of the stove into the room.

The air passing through this passage-way attained, and was maintained at, by a comfortable fire, a temperature of 80°. The highest temperature was found to be 95°, whilst the lowest on cold days, with only a small fire, was 70°. "The mean temperature of the room at the level of respiration was 61°, while the uniformity was so perfect, that thermometers hanging on three sides of the room rarely exhibited a greater difference than one degree, although two of the sides were external walls." This description of stove is better illustrated in figs. 3 and 4, the

Fig. 3.



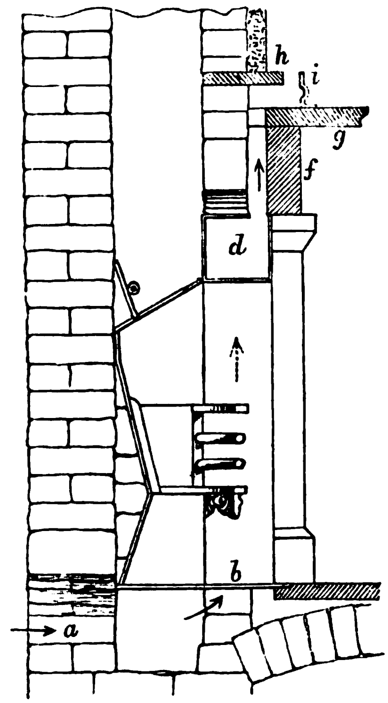




Fig. 4.

former of which is a horizontal section and the latter a vertical section of the tubular stove in its complete form. *a*, is the flue for conducting the external air to the underside of the hearth-plate *b*; *c*, *c*, are openings in the hearth-plate *b*, communicating with two upright tubes of a corresponding form, which conduct the air entering at *a*, upward to the horizontal tube *d*, above which tube is an opening or passage, the orifice of which is immediately above the mantel-shelf *g*; *f*, is the upper mantel, which stands forward 1½ inch from the chimney-breast *e*; *h*, is a thin slab of marble built into the chimney-breast, for the purpose of supporting a chimney-glass, and diverting the current of air from flowing directly up the chimney-breast; *i*, is a strip of metal (or marble), which may be moved more or less towards the slab *h*, either to diminish or stop the supply of warm air to the apartment, or a thin strip of metal may be made to act as a throttle-valve between *i*, and *h*. The arrows in the engraving fig. 5 indicate the path of circulation of the air in a room fitted with the tubular stove. Mr. Lloyd states, and we have every reason to believe that he is correct, that the advantageous results obtained by this construction are—"First, the prevention of a smoky chimney; for as provision is made for the regular inflow of air to the room, the outflow of smoke may be deemed tolerably certain, as an open window or door almost invariably secures that end. Secondly, the equal distribution of warmth, and freedom from draughts; for whilst in an ordinary stove, heat is obtained by radiation only, in this there is also a copious supply

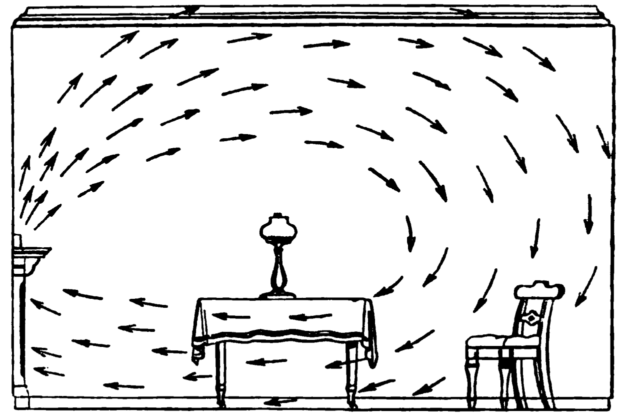


Fig. 5.

derived from the warmed air dispersed insensibly over the room. The intense heat to which the hearth, cheeks, and jambs of an ordinary stove are raised, produces through the fire a very rapid draught, which carries up the chimney a large proportion of the heat which should be diffused; but by converting the hearth-plate and jambs into air-tubes, a considerable portion of the heat given out by the fire is absorbed, and the intensity of the draught is diminished, without hindrance to a steady and continuous current up the chimney. Thirdly, complete ventilation, unaccompanied by any sensible current. There being a continuous flow of air, of a temperature exceeding that of the room, distributed over the upper part, while there is a continuous drawing off of air at the lower part by means of the fire, it follows that there will be a regular current in the upper half of the room from, and in the lower half to, the fireplace." This steady circulation of air is found to absorb and neutralise all those obnoxious draughts and currents that usually stream in from the defective construction of windows and doors, and which are increased in proportion as the apartment attains a higher temperature. As Mr. Lloyd admits, the principle on which the tubular stove is constructed is not new; but all former apparatus of this description has been costly, and objectionable from their drawing their supply of air from the apartment to be warmed, thereby not only detracting from the healthy condition of the atmosphere, but also increasing the number and strength of the draughts from the present uncertain and objectionable sources of supply for the combustion of the fire. The novelty of Mr. Lloyd's stove consists in the supply of air to be heated being derived from the external atmosphere, and also its being carried through passages in front of the fire-grate instead of at the back, thereby preventing the possibility of the air being over-heated, and admitting of regulation of its temperature. "The tubular stove warms a room partly by direct radiation and partly by communicating heat to the air which passes beneath the hearth and through the tubes, which are warmed by the radiated heat of the fire; and considering that the smallest increment of heat, say only one degree, will cause air to ascend, the tubular stove thus becomes in effect a manageable, economical, and powerful pump. A bright metallic screen placed before the fire will prevent direct radiation, and by reflecting the heat to the grate will increase the pumping power of the fire. By forming the screen so as to make it interpose between the tubes formed in the hearth, the sides, and the fire, the supply of radiant heat to the air-passages may be cut off."

Mr. Lloyd proposes to provide churches, theatres, concert-rooms, and places of public resort with hollow columns, perforated or open at top, and communicating with the basement of the building or the external atmosphere. These columns might be somewhat similar in construction to a twisted Saxon column (fig. 6), and made to play like fountains in a way that would diffuse a pure atmosphere without causing any inconvenience. Supposing the area of such rooms to be measured out into squares of 100 feet area (adequate to the accommodation of about thirty persons), and to every such sub-area there be provided one of these columns of any convenient height. The air fouled by thirty persons in an hour being not more than 120 cubic feet, the bore of this fountain, to supply it at the rate of 10 feet per second (the rate of a gentle, pleasant wind), will not exceed the area of 12 square inches, or a tube 4 inches in internal diameter. These columns may be made to support the gas or other lights (as shown in fig. 7); and in order to disperse the air in all directions equally, may be fitted with an ornamental perforated cone, gradually diminishing from the full diameter of the pillar to that necessary for the supply of a gas-burner above. This would involve an addition to the diameter of the column sufficient to admit a supply of pure air for the lights, which, if of gas, would consume about fifteen times as much air as gas; so that fifteen times the capacity of the gas-pipe, added to the above 12 square inches, will give the internal diameter of the whole pillar.


Fig. 6.

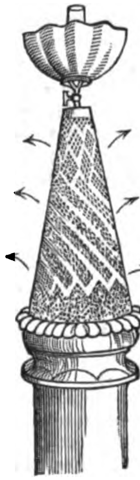


Fig. 7.

These air-fountains, in connection with a proper provision for drawing off the vitiated air, and applied at the proper points of the building, would be a great improvement upon the present absurd system of providing an escape for air at the top of apartments without means of supply, but allowing the air to find its way as it best can through chinks or ill-made or open doors and windows, to the great danger and annoyance of the occupants.

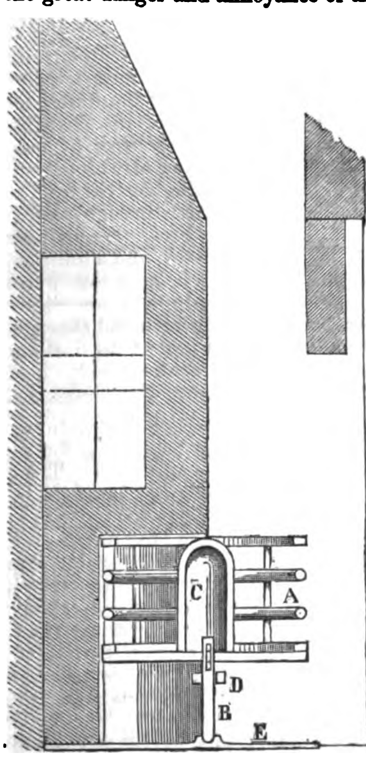


Fig. 8.

Mr. Lloyd also proposes a simple contrivance for the consumption of smoke in domestic fires, which, from his own experience, he states to be convenient and economical. Fig. 8 represents a vertical section of this apparatus. A, is a circular fire-grate, consisting of four circles of bars, separated by pins, and fastened to an iron cross; B, the vertical spindle, to which the grate is firmly secured by means of keys above and below the cross; C, is a hollow cylinder of iron or fire-clay, with a hemispherical top having a slit in it. This cylinder rests on the cross, and is open at its lower end. D, is an iron bar, with a coupling to embrace the spindle immediately below the fire-grate A; E, is an iron hearth-plate, having a hollow boss to receive the end of the spindle B. The brickwork was built with a semicircular recess, to receive one-half of the circular grate, above which was placed a Welsh lump, about half-an-inch from the top, thus completely inclosing the half of the grate. The fire being lighted and got well up in the whole circle of the grate, fresh coals are put on the half projecting from the brickwork, and the grate is turned half round on its axis B. A clear, bright fire is then apparent in front, while the gases and smoke from the fresh coals at the back make their way forward to the edge of the Welsh lump, where they are subjected to the heat of the clear front fire, whilst the stream of air passing up the hollow cylinder C, escapes by the slit, commingles with the smoke, gases, &c., and ensures their almost perfect combustion. A clear fire with a semicircular face, well adapted to the radiation of heat, is thus always presented to the room.

This description of fireplace may be modified so as to combine the warming and ventilating effects of the stoves before described, as well as to retain its own peculiar advantages, and thereby prevent any heat from being absorbed by the brickwork immediately around the circular fire-grate.

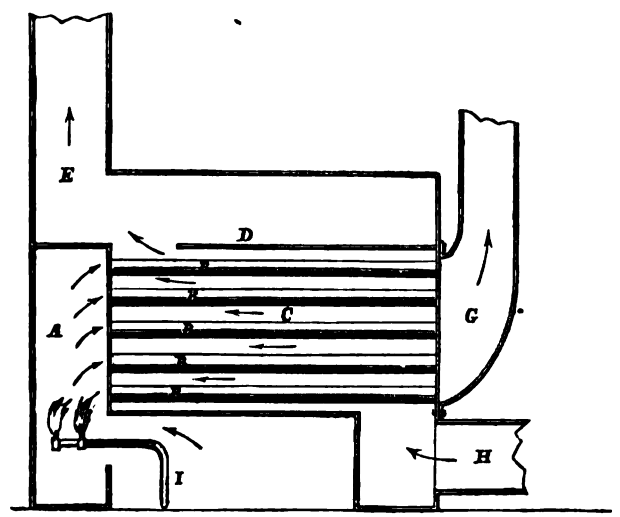


Fig. 9.

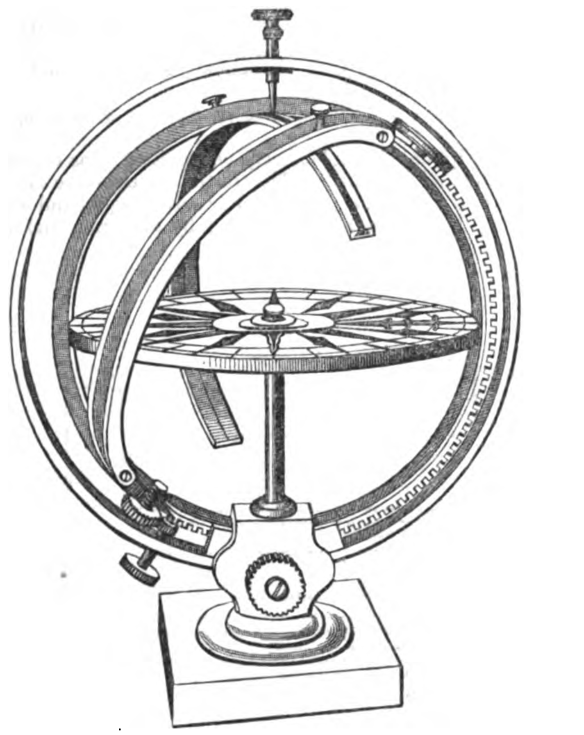
Fig. 9 shows an arrangement for a gas-stove, having for its object the prevention of any loss of heat given out by the combustion of the gas, with the exception of what little is carried off by the noxious vapours up the chimney; but this escape is found to produce considerable ventilating effect. A, is the gas-box, and B, a series of horizontal pipes or smoke tubes, each 20 inches long and $\frac{3}{4}$-inch diameter, affording a heating surface of 1020 square inches; C, is the air-chamber attached to the gas-box A, and through which the smoke-tubes pass; G, is the chimney-tube connected with the chamber C; H, is a tube for conducting external air to the chamber C; D, is a sliding-plate of metal resting on the smoke-tubes B; E, is a tube attached to the air-chamber over the gas-box, to assist the ascent of air through C; F, is the gas-pipe and burners.

Supposing the gas to be burning and the tube H, open, it is evident, that while the gas is flowing from left to right, a supply of fresh air will flow from right to left, and effectually take up the heat radiated by the tube B, while the air from the apartment supplies the burners through the opening at which the gas-pipe is placed. In order to diminish the quantity of heat taken up by the fresh air, the plate D, may be moved to the left, in which case the air will pass directly upwards, and over the plate D, instead of sweeping the whole length of the pipes B. The same arrangement on a larger scale would be economical for the combustion of coal, compared with the ordinary open fire-grate, a large proportion of the heat of which passes off up the chimney.

The observations of Mr. Lloyd respecting the humidity of the essential atmosphere of dwellings, are especially worthy of perusal. The sanitary condition of the air by which we are surrounded has hitherto received but little general attention, notwithstanding its great importance, especially in rooms or buildings heated by close stoves, hot-air stoves, steam, or hot-water pipes. In these cases, small fountains or open vessels of water or steam-jets might be very beneficially employed. In conclusion, we may remark, that all the apparatus suggested by Mr. Lloyd have stood the test of experiment, and been found to answer admirably the purposes intended. They are therefore entitled to more consideration than the untried theories of most of the ventilating savans of the day.

## THE GREAT CIRCLE COURSE INDICATOR.

Lieutenant E. D. Ashe, R.N. *Inventor.**



Lieutenant Ashe, of the Royal Navy, the talented director of the observatory at Quebec, previous to leaving this country in the autumn of 1850 for Quebec, devised a simple useful instrument for the purpose of finding the Great Circle course and distance between places for the use of navigators. It was at the time when Great Circle sailing was regaining attention; and lectures were given here and there on a subject which was soon found to be scarcely worth while to lecture on. But Lieut. Ashe made no essay on this ground, and, starting for his destination, left his views on the subject to be carried out while he proceeded to his business at Quebec. The 'Nautical Magazine,' as the general receptacle of any inventions likely to become useful to seamen, is the fittest place for its description; and we have, therefore, prepared the following account of it for our readers, under the name given to it by its inventor as "The Great Circle Course Indicator."

The meridian circle inside the large outer one is supported by a brass socket attached to the stand of the instrument at the nadir. The outer circle carries the zenith point, which is raised or depressed by a screw at pleasure. This meridian circle is also moveable by a screw in the brass socket which carries it, so that by altering its place in the socket the poles may be elevated or depressed as required. The anterior or elevated portion of this meridian circle consists of two semicircles moveable at the poles, marked east and west, these being similar to each other and graduated in degrees and minutes, are readily adjusted and fixed at any angle by a clamp screw. Another screw moves these semicircles in azimuth, and they are then fixed at the required angle by the clamp screw.

A moveable arc traverses these moveable meridians in any direction and, continuing to the horizon, indicates the course to be steered by compass at the point on the compass card intersected by it. This moveable arc, called the course indicator, is fitted with two brass pointers (intended to represent the ship), so as to slide easily in a groove on this arc and to show the places of departure and arrival; and this arc is adjusted as follows:

The moveable meridians are opened to an angle equal to the difference of longitude between the place of departure and arrival, measured by the moveable arc being brought to the equator of both, and are fixed at that angle by the clamp screw. The moveable arc is then released, and when the place of arrival is west of the departure the zero on this arc is clamped at the latitude of the place of the departure on the eastern meridian. The arc is then brought to coincide with the latitude of the place of arrival on the western meridian. The zero of this arc or the point of departure on the eastern meridian being then brought under the zenith point, the intercepted arc then represents the distance to be sailed over, and the intersection of the same arc on the compass card beneath it gives the course to be steered, and the distance is read off on that portion of the arc C, that is intercepted between the two meridians.

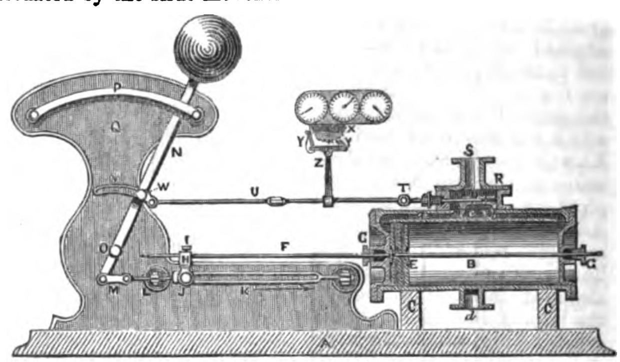
It may be as well to remark that the north and south points of this card being fixed so as to coincide with the outer meridian circle the course thus read off is the true course, to be corrected for variation and local attraction before adopting it with the binnacle compass.

* From the 'Nautical Magazine and Naval Chronicle.'

## CYLINDER WATER-METER.

J. Hartin, *Patentee*, May, 1853.

This meter, which is an American invention, consists of a simple arrangement of a cylinder and piston, fitted with slide-valves, for the ingress and exit of the water to be measured; the cylinder, which is the actual measuring vessel, being filled at each stroke of the piston, after which the slide-valve is reversed, when the water escapes, and a fresh supply is admitted on the opposite side of the piston. This action therefore keeps a reciprocating movement of the piston, and the registration of the measured fluid is effected by a counter attached to the valve-spindle, and actuated by the slide movement.




The annexed engraving is a sectional elevation of the meter complete. At A, is a wooden or base-plate, for supporting the cylinder and working parts of the apparatus. The cylinder B, is carried by the two vertical supporting brackets C, and is fitted by a slide-valve D, and piston E, screwed on to the piston-rod F. This rod passes through a stuffing-box G, in each end of the measuring cylinder, and has a short adjustable arm H, screwed to it near its outer extremity by a pinching screw I. The lower end of this arm is fitted with a stud-pin J, which works in the longitudinal slotted-rod K. This rod slides in the fixed bearings L, which are bolted to the main vertical portion of the framing. The outer extremity of the slotted rod is connected by a short link M, with the lower end of the vertical weighted tumbling lever N, working on a fixed centre O. The upper end of this lever is guided in its movements by the segmental guide-plates P, which are carried by a pillar Q, bolted to the main framing. The slide D, is contained in the chamber R, which is furnished with an inlet-pipe S, and the spindle of the slide is jointed at T, to one end of the adjustable connecting-rod U. The opposite end of this rod is jointed to the segmentally-slotted plate V, in which works a stud-pin W, fitted into the lever. The slot on this segmental plate is rather shorter than the traverse of the pin in the lever, so that, when the lever is caused to oscillate or vibrate, a certain amount of traverse is given to the slide D. The movement of the lever N, is effected by the stud-pin J, in the slotted rod K, the slot in this rod being shorter than the stroke of the piston; and consequently, when the pin arrives at the end of the slot, the further traverse of the piston slides the rod K, in its bearings, and thereby turns the lever N, on its fixed centre O. The registration is effected by the ratchet-wheel X, actuated at every stroke of the slide by the pawls Y, fitted to the T-lever Z, which is secured to the connecting-rod of the valve-spindle.

In measuring fluids by this meter, the fluid to be measured enters by the inlet-pipe S, into the chamber R, whence it passes along the open part *a*, into the corresponding end of the cylinder B. The pressure of the fluid forces the piston to the opposite end of the cylinder, thereby causing the pin J, to traverse along the slotted rod K, and move it in the direction of the arrow. This movement of the rod reverses the lever N, which effects the movement of the slide D, by means of the stud-pin W, and slotted link V. By this means, the port *b*, is opened suddenly, and the fluid is allowed to enter the oposite end of the cylinder, thereby forcing the piston back again, and consequently expelling the fluid which was contained above the piston; this fluid escapes by the egress port *c*, which is now in communication with the inlet thoroughfare *a*. A hollow zone or belt is cast round the cylinder, and forms the outlet for the fluid which pours into the source-pipe through the branch-pipe *d*, cast in one piece with the cylinder. By fitting a moveable false bottom or end to the cylinder, so as to be capable of adjustment by an external screw or other movement, the capacity of the cylinder may be regulated to the greatest nicety, by simply screwing or setting in or out the internal false bottom.

## THE FOUNTAINS OF CONSTANTINOPLE.*

*(Concluded from page 85.)*

As the Turkish capital lies at the feet of such an extensive mountain range as that of the Hæmus, there is no other city in Europe which can be compared with it in the rich and abundant supply of pure and healthful water. In this respect, the great meadow of Pacha Dshaïri is now to be alluded to. It is situated one hour's distance from Ejub, and in perforating the soil to the depth of only a few feet, abundant springs of water are found. The mountains of Karamatli, distant six miles from the gate of Adrianople, furnish also great quantities of water, which has been conducted in various directions. The heights of Kalkali, east of St. Stephano, likewise abound with springs. The water of the two latter localities passes in two parallel stone pipes over the Aqueduct of Chavass Kiöi. In the vicinity of the Adrianople gate is a valley towards Ponte Piccolo, whose springs have also been collected. The springs of the two hills on which lie the villages of Nifez and Aïpa, near the slope of the sea, have also been gathered up and led to the metropolis. The springs on the hills of Baluki have been similarly made use of, and show the great impulse which the laws of Mahomet and their injunction of cleanliness and copious ablutions, have given to the engineering works of the Turkish capital; and thus the arrangements for supplying that city and its suburbs with water may be reckoned amongst the most complete and interesting of any of the towns of the modern world. From a very accurate computation deduced from especial tables, it appears that the fifteen separate springs or systems of watercourses used for the numerous aqueducts and other works of Constantinople, yield a daily supply of 249 lulchs, equivalent to 12,267,532 kilogrammes; and computing the population at 600,000, the daily supply for each person amounts to 20·44 kilogrammes, or about 5 gallons.

Equally surprising is the number of fountains, which are to be met with not only at every mosque, but in every part of the city, and amounting altogether to about five hundred. The founding of a well is one of the most esteemed acts of Moslem religious charity; and if the means of one individual are insufficient to erect such a monument, several persons combine their funds and erect a little pavilion, where dervishes distribute fresh water to the believers at all hours of the day. It is upon these structures that Turkish architects and artists employ their whole talent and ingenuity. The railings are most skilfully made, and the columns have long inscriptions concerning the piety and morals of the passers-by, and reminding men of the benefactions they receive from the dews of heaven and the sources of the earth.

The richness of ornamentation and the elegance of design of some of these buildings are surprising, in which qualities, however, the fountain of Sultan Achmet III. surpasses all others. It stands in the square of the Seraglio, in the ancient Augusterca, and comprises a reservoir, a fountain, and a pavilion. Its ornaments are splendid in the extreme, and, like the other fountains of Constantinople, it consists of a huge mass of masonry. A corridor runs throughout the whole interior of the building, and leads to the towers situated at the corners, which serve for the distribution of the water. The water gushes from the mouths of several cranes, placed symmetrically at each façade. Inscriptions, apothegms in gilt letters, cartouches, arabesques, executed with much splendour upon marble and lapis-lazuli, give to the building, covered thus from top to bottom, a splendid appearance, which is not impaired by a critical and minute examination. A special inscription, composed by Sultan Achmet himself, records the founding of the structure.

The small fountain which stands near Sta. Sophia, appears to be of the same epoch as that of the Seraglio, although it is without any inscription. The ornaments present all the Arabic character of the monuments of Asia Minor,—a style preserved up to the reign of Sultan Osman III., who employed Italian artists, and even sent students to Italy to cultivate the fine arts. At that period, however (1680-1720), Italian architecture had already lost its purer character, and the taste for puerile and trifling ornamentation was extended thence all over Europe, Turkey not excepted. If we, however, examine the ornaments of Arabic structures, we find that the right line and the circle form the basis of all combination. No other nation has ever pushed geometrical combination so far, for obtaining forms for architectural ornamentation. The necessity imposed upon the Mahomedans, of abstaining from all representation of men and animals, has made their art pursue a path to which other nations were not confined. But although they might have found on the Byzantine buildings of Constantinople, a number of objects bearing on the principles and practice of ancient architecture, yet they never once imitated the ornaments of the Greeks, although they took their patterns from Byzantine buildings in a structural point of view. The large Turkish mosques, albeit some of them are almost servile imitations of Sta. Sophia, still exhibit ornaments in accordance with the principles of the buildings of Brussa, Siwas, or Korieh in Asia Minor.

If we draw geometrical plans from all these combinations, the particular complications of the circular arches of doors and niches of the mosques vanish, and we find that a very small number of fundamental forms and polyhedrons is sufficient for the construction of the most complex vaults of arches. A very general ornament of the monuments of Constantinople is that composed of portions of a pyramid between two inclined planes, and is formed of right lines and planes, and seems somewhat an imitation of a similar device of the ancients; still, it is not to be met with on the monuments of either Spain or Egypt. This ornament, changed into a variety of forms, is the governing principle of the capitals of the Turkish order, as prevailing in Constantinople and Asia Minor. These forms, apparently so bizarre, can always be reduced, as well in the ground plan as in elevation, to geometric forms of great simplicity. The elegant form of this ornament arises from a certain number of circles of different diameter. Flowers, as ornaments of these interlacements, are constantly to be met with, and many of fantastic shape are often commingled with the forms of real flowers, as the tulip, pink, and bindweed.

The cypress is an ornament much used on Turkish fountains and tombs, and is associated with the religious and mystic conceptions of the Eastern nations. The cypress, even in the earliest ages, was considered as a symbol of the mind, as its obelisk-like shape, rising towards the sky, was regarded as an image of that divine flame which animates humanity. It is to be met with on the oldest monuments of Persepolis and Bisutun, as also on the miniature paintings of Persian MSS. The cypress is, moreover, the constituent of all the ornaments on Indian tissues, which in Europe are erroneously considered and termed *palms*. These

* Abridged from the 'Allgemeine Bauzeitung.'

so-called palms of Indian cachmeres are, in fact, only diversely coloured cypresses, which, however, always exhibit the pyramidal form. The fountain of Sta. Sophia affords some samples of this ornament,—at first the straight and perpendicular tree, then the same tree with a somewhat bent crown, and again this tree of the graves with its branches intertwined with flowers and garlands. As soon as the oriental painters had seized the idea of enlivening the dark green of the cypress by the addition of flowers, they soon invented those designs which we admire on their tissues, and which have not been changed for many centuries.

Although the richest marbles have been used in the construction of the public buildings at Constantinople, still the prevalent taste of the Oriental nations for vivid colours was not satisfied by this variety of tint, and the sculptures of the monuments of that city are likewise painted and gilded. It is to be regretted that the custom, and even the art of painting and gilding stone in a permanent manner, seems to be lost in the East, and at the present moment the Turkish artists are satisfied to gild marble like they do wood. Some still follow the old method of soaking the stone carving in a hot solution of alum, then employ the colour, and afterwards lay on a varnish of mastic from the Island of Chios. It is further to be observed, that the Turks are very attentive in choosing for their fountains the most picturesque spots, as exemplified by that of Sultan Selim on the Bosphorus, which commands views of the Castles of the Dardanelles and the surrounding charming scenery.

## THE NEW THEATRE AT AIX-LA-CHAPELLE.*

HOF-BAURATH CREMER, *Architect.*

(*With Engravings, Plate* XIX.)

IT is a remarkable observation, that those buildings of larger structure which are destined not so much for common use and practical purposes, as for the more ethic aims of social life, have considerably fallen off, compared with what they were some few years ago. Architectural activity has *not* decreased; on the contrary, it has become more extensive—the sense for artistic forms has been successively developed and increased; but the scope and aim of the building art has changed, and with this other demands have arisen, and other modes and kinds of construction have become necessary, out of which (as has always been the case) a *new style* of architecture will ultimately take its rise.

The Theatre of Aix-la-Chapelle was built in the years 1823-24; but as little has been published as to this class of buildings, and as an important enlargement has recently been made to it, the following details will perhaps be interesting. Aix-la-Chapelle, renowned for its mineral baths, possessed but recently a small, badly-constructed theatre, being, moreover, inadequate to the increased population of the city. Thus arose the plan carried out by the architect, and subsequently enlarged, as remains to be stated. The simple motives for adopting this style and detail of construction will be best understood from the following particulars.

Fig. 1, a ground plan of the lower story.—1, pronaos; 2, vestibule; 3, money and check takers; 4, second vestibule; 5, staircases to the orchestra and its accessory rooms; 6, dwelling of the restaurateurs; 7, kitchen, communicating by a staircase with an area kitchen; 8, refreshment saloon; 9, passage to the ground-floor boxes; 10, staircases to the different boxes and to the gallery; 11, entrance; 12, spaces for storing the properties; 13, entrances to the pit; 14, entrance to the reserved seats; 15, ground-floor boxes; 16, reserved seats; 17, pit; 18, orchestra; 19, vaulted spaces providing the hypocausts for warming the interior; 20, staircases to the boxes of the proscenium and the roof; 21, lateral portals, which are opened at the end of the performance; 22, scenery; 23, staircases to the wardrobes and the galleries for the machinery; 24, vestibule for the scenery; 25, dwellings of the steward; 26, greenroom; 27, stairs leading to the wardrobes; 28, waterclosets; 29, a brook, which passes in proximity to the theatre.

Fig. 2, the ground plan of the second story and galleries.—1, passage; 2, galleries; 3, boxes of the actors; 4, staircase to the roof; 5, landing place; 6, sleeping-room of the restaurateurs; 7, an orchestra for music and dancing; 8, galleries of the stage machinery; 9, suspended wings; 10, landing-place; 11, wardrobes; 12, staircase to the roof.

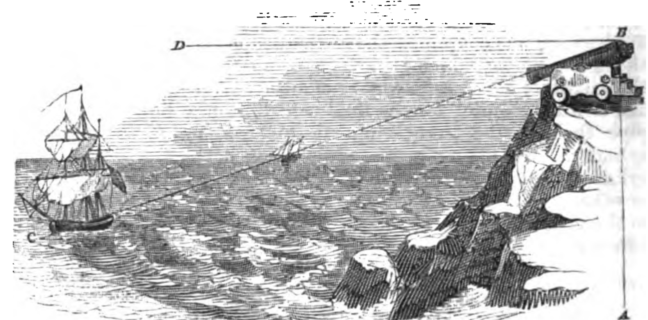
Of these spaces, the audience of a full house will contain, in the pit, 243 persons; in reserved seats, 107; in the ground-floor boxes, 100; in the first tier of boxes, 160; second tier, 170; gallery, 400: total 1180 persons.

The main walls of the building were made of bricks. The base, the open stairs, and the pronaos, with the exception of the capitals and bases of the columns, which are made of marble of Namur, are of the limestone from the quarries near Eupen. The sculptures of the main pediment were made of the marble stone from St. Petersburgh, near Martrich. The foundation occasioned much expense and trouble, as a plate of oak had to be previously laid down.

* From the 'Allgemeine Bauzeitung.'

## MEASUREMENT OF INACCESSIBLE DISTANCES BY INSPECTION.

By ALEXANDER ALCOCK.*




I am induced to forward you the following plan, which I proposed to be followed in large fortifications, some twenty-five years ago for determining with little more than inspection, the distances of objects on the horizontal plane, from any fortified position on an eminence. The principles upon which my plan was adopted are of course found in geometry and trigonometry, I only allude to their adaptation to the construction of tables, necessary to be calculated and kept in each battery for inspection.

Let B, be the position of a gun on an eminence, whose height B A, above the level of the sea is known; C, the position of a ship or other object on the horizontal plane; suppose B D to be drawn parallel to A C. Lay the gun by the line of metal for the object at C, and with a quadrant determine the angle of depression D B C, which will be the measure of B C A, the alternate angle. Now in the right-angle triangle A B C, we have three quantities given to find all the rest. Then as the sine of A C B, is to A B, so is radius to B C, the inaccessible distance. Thus we obtain a common formula, namely, the height of the piece above the horizontal plane divided by the sine of the angle of depression will in all cases give the distance of the inaccessible object from the gun.

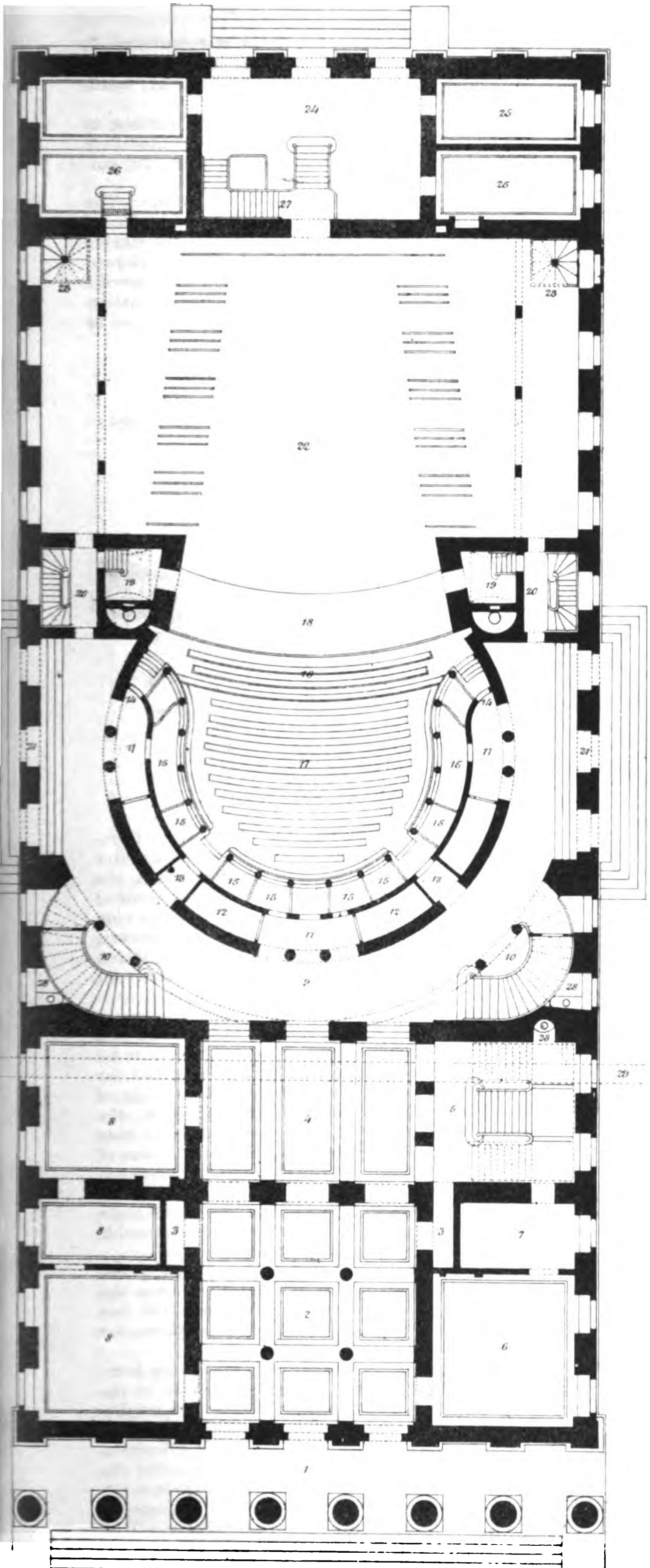
Being quartered in the garison of Gibraltar for some years, where batteries are to be found at various elevations from the horizontal plane to the rock mortar, which is about 1296 feet above the sea, I proposed to calculate and construct tables for every battery on the foregoing data, as follows:—

Take a card in the form of a rectangle, and on the top horizontal line place all the angles within the capabilities of the piece, and on the left hand vertical side, place the several heights of the batteries, then draw cross lines, and under each angle and opposite each height, insert at the intersection the calculated ranges. Thus when you lay the gun for an object, and find the angle of depression, all that is necessary to do is to look down the column under the angle found, and opposite the corresponding height of the battery already known, and the distance will be found in yards.

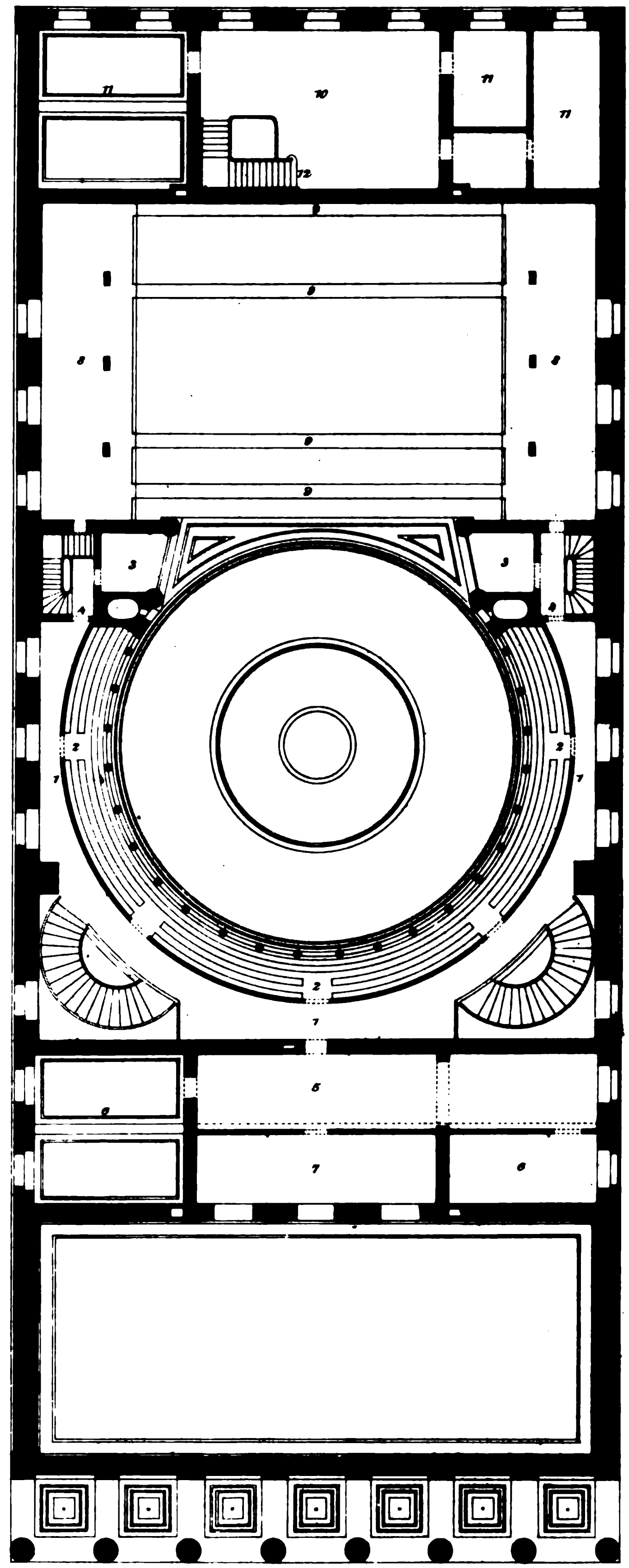
* From the 'Scientific American.'

# THEATRE AT AIX-LA-CHAPELLE.

Ground Plan or Pit Floor



Plan of Gallery Floor.



Scale 10 5 0 10 20 30 40 50 100 Rhenish Ft

## THE COMMISSIONERS OF SEWERS AND THE GENERAL BOARD OF HEALTH.

Sir—In the former article on the above subject, forwarded by me, which appeared at page 125 of your last month's Number, "impermeable," in the last paragraph but two, has been printed "imperishable;" thus giving to the sewers of the Board of Health a character which it is to be feared they will never merit, even in the lowest acceptation of the term;—and in the last paragraph but one, "empiric" has been printed "empereur."

As you have now favoured your scientific readers with a copy of Mr. Ward's letter to the Home Secretary, every one is much surprised that so miserable a production could have been entertained at all, much less acted upon, by so able a diplomatist as his lordship of the Home Office. It is, however, not given to poor humanity to be perfect in all branches,—it is one thing to be expert at diplomacy, and another thing to be quite at home in sewers and cesspools.

The general opinion is that, in keeping with the fashion of the times, there is some secret correspondence or secret influence between the high contracting parties, as the few contradictory and inconclusive remarks contained in Mr. Ward's letter appear to all reflecting men to be utterly insufficient to base an important decision upon; and especially as that decision conveyed a direct censure, if not an insult, to the Metropolitan Commissioners of Sewers, who are acting under a specific statute, and giving their services gratuitously.

Mr. Ward's letter is exclusively confined to the subject of house drainage—not by any means the most important or the most difficult portion of the general system; and it may be fairly questioned, whether the reasons, as stated in Mr. Ward's letter, which influence the Metropolitan Commissioners of Sewers in their practice of house drainage, are not more substantial than the reasons which are given in favour of the mode adopted by the Board of Health, notwithstanding the evident one-sidedness of the entire document.

If Mr. Ward be at all qualified to act as umpire in these matters, he must be aware that there are, in the average of all towns, quite as many, if not a greater number, of front areas and front kitchens to drain to the rear under the house on the Board of Health system of back drainage, as there are back area drainage to be brought to the front under the house on the system usually practised by the Metropolitan Commissioners. He must also be aware, that there are numerous cases of sunk stories where there are no back areas in which to place the "tubular sub-main" of which he speaks, and in which case the sub-main must be dug some 8 or 10 feet into the ground of the back-gardens, to the manifest destruction of private property, and the great annoyance of the inhabitants. But it is absurd to discuss the subject on the supposition of a uniform practice in every variety of circumstance; each case must be treated on its own peculiar merits, after a careful examination on the ground. This mode of proceeding, it is true, will require the exercise of talent and skill; and the only plausible reason that can be given for the adoption of the *stereotyped process* is the want of talent in the parties carrying out drainage operations upon this absurd system. Nor could men of talent be found who would submit to be trammelled by an absurd uniformity of practice, where the circumstances are constantly changing.

It is somewhat singular, that the advocate of the Board of Health could not find an example in the drainage operations of that Board to hold up as an example to the Commissioners, but is driven to the necessity of quoting the Commissioners against themselves. The Commissioners, Mr. Ward states, "have allowed thirty-two houses to be drained by four tubular back drains, which act perfectly well, quite as well as thirty-two separate drains could act, though these would have cost eight times as much; and they [the Board of Health] ask why this eight-fold cost should be imposed upon London at large by the very same authority which sanctioned in this [Lambeth] square the combined drainage, which is found to work well?"

It would be difficult to find a greater number of fallacies in so few words in the loosest possible statements which are brought before the public for the purposes of puffing and deception. This statement supposes that the "four tubular back drains" are each equal in length to the extent of the thirty-two houses,—that the thirty-two separate drains from the houses into the street-drain (which is considered the invariable practice of the Commissioners), would each be as long as each of the four back drains. No account is taken of the short junction drains from the houses to the four back drains, otherwise it is probable that the front drainage into an existing street sewer, or one necessary to be formed, would be the cheaper mode of the two. It also supposes, that the Commissioners invariably drain only one house by one drain, although in a former part of the letter it is stated that the Commissioners forbid "more than two houses being relieved by one pipe-drain."

In arriving at a conclusion, however, Mr. Ward does not consider it necessary to recollect his premises, even when he has any, which is but seldom. Thirty-two drains (which should be sixteen) are divided by four, without any reference to *length, capacity*, or *expense*, and, presto! out comes an "eight-fold cost," which this sapient writer fears will be "imposed upon London at large;" as if London at large could be drained advantageously in the same manner as the thirty-two houses in question.

It is to be hoped for the honour of the professions, that Mr. Ward is neither an engineer nor an architect, nor even one of the more advanced pupils of the Board of Health; and it is quite clear that his epistle should not be disturbed in its progress to oblivion, had it not been treated as a document of considerable importance by the Home Secretary,—and from the nature of our institutions, the Home Secretary for the time being possesses the power of doing much good or much evil, accordingly as he takes the advice of wise men or of fools.

Considering the failure of the great water scheme, and the great interment scheme proposed by the Board of Health, or more properly by Mr. Chadwick, and the impediments which these foolish projects have thrown into the way of legitimate undertakings; considering, also, the slow progress made in the drainage operations of the towns under the Board of Health, and the many instances of failure in the executed works, it would be difficult at the present moment to point to a case which more loudly calls for a searching investigation by a committee of the House of Commons, or by a scientific commission, than the working of the whole operations of the Board of Health.

C. E.

## DRAINAGE OF THE METROPOLIS.

Report *to the Metropolitan Commissioners of Sewers upon the Sewage Interception and Main Drainage of the Districts North of the Thames.*

Gentlemen—In pursuance of the resolution of your General Committee of the 24th May last, followed by an order of Court on the 2nd June, associating us for the purpose of remodelling the scheme of the late Mr. Forster for the main drainage of London, so as to accord with the views of the Consulting Engineers of the Commission, we have now the honour of laying before you the conclusions at which we have arrived, with reference to the districts north of the Thames, reserving for a future Report the remaining portion of the main southern drainage, which is not embraced in the Reports of your engineers presented in October last.

The sewers recommended in those Reports, forming portions of the entire scheme for the main drainage of London, are designed to serve the double purpose of drainage and interception; for they will not only drain the districts through which they pass, but also intercept the sewage of those districts from its more direct course towards the Thames, turning it eastward until it can be discharged into that river at a more convenient spot lower down. Of the additional sewers proposed in the present Report, some, in like manner, possess that double character, whilst others are simply "intercepting sewers," adding nothing to the drainage of the districts they pass through, but merely giving a direction to the flow of the sewage which they will receive from the drainage sewers.

The scheme proposed by Mr. Forster in January 1851, for the drainage of the districts north of the Thames, comprehended generally the interception from that river of the sewage of most of these districts. It also contemplated some provision for future increase of population on an area of about thirty-nine or forty square miles. But it provided neither main outlet lines for such districts as needed them, nor the means of interception for any district beyond the area named; these being subjects, as shown by his Report and plan, intended to be dealt with by him at a future period.

After careful consideration of the necessities of various districts, for many of which the main outlet lines are deficient in capacity or are entirely wanting, and bearing in mind the rapid increase of the population over the very large area not included in Mr. Forster's plan, it appeared to us essential, that in completing our scheme, all these more extended requirements should be held in one general view, and should be arranged, as far as practicable, in connection with the plan of interception of sewage from the Thames. This course we have adopted; and accordingly we have extended our scheme over an area of about fifty-nine square miles, instead of confining it to the forty square miles which Mr. Forster's plan embraced. Moreover, we propose to render the scheme adequate to the requirements of a population exceeding the present number by upwards of one-half. Although therefore our estimate may at first sight appear more costly than that of Mr. Forster, it is not so in reality; inasmuch as it is more comprehensive, embracing objects for which his scheme, as propounded in 1851, did not make provision, but which must have been provided for eventually, with a corresponding addition to his estimate.

The area included in our present design comprises about fifty-nine square miles, which we have subdivided into four districts, to be dealt with according to their varied requirements, so as to secure for each of them the particular objects sought to be accomplished.

These approximate areas are as follows:—1. Northern high-level area, 14; 2. Middle-level area, 16; 3. Low-level area, 11·1; 4. Western division, 18: total, 59·1 square miles. The lengths, sizes, and inclinations of the proposed sewers, hereinafter described, are, for the sake of brevity and convenience of reference, given in a tabulated form in the summary.

### I.—Northern High-Level Area.

This district, comprising about 8913 acres, or 14 square miles, is bounded on the north by a water-shed line, about Hackney, Homerton, Clapton, Stamford-hill, Highgate, and Hampstead; on the south, by the Regent's-park, Camden-town, Holloway, Dalston, and the Victoria-park; on the east, by the River Lea at Stratford; and on the west by the Edgeware-road at Kilburn.

The district has a natural valley line, defined by the Hackney-brook open sewer, which runs from west to east through a great portion of its length. The surface falls from the northern edge with considerable inclination, and from the southern portion with a gentle inclination towards this valley line.

At the present time this area is suburban in character. Its population is limited, but rapidly increasing. It is in immediate want, for the general extension of the district sewers, of main outfall lines, which therefore require designing, with reference to future as well as present necessities.

The wants of this district, as regards both arterial drainage and interception. have been provided for by the plan of Mr. Bazalgette, described in his report of the 1st October 1853, for the details of which we beg to refer to the Report itself.*

### II.—Middle-Level Area.

This district, comprising about 10,260 acres, or about sixteen square miles, is bounded on the north by the southern margin of the high-level drainage area, Willsden-green and Harlesden-green; on the south by Bethnal-green, Old-street-road, Lincoln's-inn-fields, Piccadilly, Hyde-park, Oxford-street, Notting-hill, Wormwood-scrubs, and Acton; on the west, by Hanger-hill, near Ealing; and on the east by the River Lea, at Old Ford, near Stratford.

Of this area the largest portion is closely populated; and probably its population has nearly reached its maximum density. Its western portion is suburban in character, but is rapidly being covered in every direction with human dwellings. Its levels are such as will enable the sewage to be conveyed by gravitation to the level of Trinity high water, beyond the eastern extremity of the metropolis. With one exception,† its middle and eastern portions are provided with main outfall lines, which will be found sufficient when the intercepting lines of sewers are built. Its western extremity on the contrary, is in want of adequate main outfalls. We propose for this area a main line of sewers, which shall serve for the drainage of the district itself, as well as form part of the general scheme of interception.

The sewer will commence at Acton, thence proceed in an easterly direction, and pass under the North and South Western Junction Railway, by the side of the Great Western Railway, and under the West London Railway, near which it will intercept the Counters' Creek sewer; it will then proceed into the Uxbridge road at Notting-hill, and continuing along that road to Gloucester-road, will join the Ranelagh sewer. Between Acton and the Gloucester-road, it will fulfil all the duties of a district sewer, receiving both collateral sewers and house drains, and carrying off all the flood waters, which latter will at this point be discharged into the Ranelagh sewer. Eastward of the Ranelagh, it will become solely an intercepting sewer, and will proceed by the way of Oxford-street, intercepting the King's Scholars' Pond sewer at Duke-street, Grosvenor-square. At the Regent-circus it will join with the Regent-street sewer, thence it will continue along Oxford-street, New Oxford-street, Hart-street, King's-road, Liquorpond-street, and Back-hill, where it will intercept the Fleet. It will then proceed along Ray-street, across Clerkenwell-green, and St. John's-square to Wilderness-row, thence by the way of Old-street-road and New-inn-yard to High-street, Shoreditch, along Church-street, Bethnal-green-road, and Green-street to the Regent's Canal (beneath which it will pass), along Old Ford-lane, and beneath the East Indian Dock Railway, near Sir George Duckett's Canal, at which point a junction will be effected with the northern high-level sewer, with which it will be carried over the River Lea, near Old Ford, at such an elevation as to enable it to be continued eastward to Barking Creek, and at that point to discharge into the Thames at high water.

Upon its course it receives two branches, projected with the view of intercepting as much sewage as possible, for delivery by gravitation at high water. The first branch commences at Curzon-street, Piccadilly, and proceeds by the way of Leicester-square, Chandos-street, Covent-garden, and Lincoln's-inn-fields, and joins the main branch at King's-road, Gray's-inn-lane. The second branch commences at Commercial-street, Whitechapel, and proceeds by Old Montague-street, Buck's-row, Devonshire-street West, beneath the Eastern Counties Railway, and along West-street, to a junction with the main line at Green-street.

### III.—Low-Level Area.

This district comprises about 7100 acres, or 11·1 square miles. It is bounded on the north by the lower margin of the middle level area; on the south, by the River Thames; on the east, by the River Lea; and on the west, by Kensington-gardens, Brompton, and Chelsea Hospital. Its levels are such, that a large portion of it cannot be drained by gravitation, except at low water; the aid of pumping is therefore absolutely essential, in order both to drain it effectually and intercept its sewage from the Thames.

Like the central portion of the middle-level district, the largest portion of the low-level area is densely populated, and little or no increase in population can be anticipated; the quantity of sewage to be provided for may therefore be determined with tolerable accuracy. With one exception, about Bromley and Bow Common, this district is sufficiently provided with main outfall lines, some of which however require alteration and repair.

The line proposed for the interception of the sewage of this district, commences by a junction with the Ranelagh sewer at Grosvenor-row, Queen's-road, Chelsea. It passes along Queen-street and Belgrave-place, to a junction with the Victoria-street sewer, at the western end of the latter, near to which it intercepts the King's Scholars' Pond sewer. The Victoria-street sewer then becomes an integral portion of the main line as far as Parliament-street, at the northern end of which the sewer leaves the Victoria-street sewer (which will now discharge the office of a flood outlet) and is continued by Whitehall to Charing-cross, where it receives the contents of the Regent-street and Northumberland-street sewers, and then proceeds by the Strand, intercepting the Essex-street sewer at the west end of Essex-street. It then passes along Fleet-street to New Bridge-street, where it intercepts the Fleet. It then crosses New Bridge-street, passes along Crescent-place under houses to Shoemaker-row, along Great and Little Carter lanes, Cannon-street West, and Cannon-street to King William-street, where it intercepts the London-bridge sewer; thence it proceeds through Eastcheap, Great and Little Tower streets, and Tower-hill, to the Minories, there intercepting the Irongate sewer; thence by Royal Mint-street, Cable-street, Back-road,

* Mr. Bazalgette's Report, referred to above, was given in the *Journal* for November 1853, p. 401.

† Allusion is here made to the want of an outfall sewer, for flood-waters only, running due south from Bethnal-green to the Thames. Such a sewer would serve also the purpose of a district drainage sewer. The latter, indeed, would be its principal character.

Brook-street, and under the London and Blackwall Railway, near Stepney Station, to and along the Commercial-road, and under the Regent's Canal, to the Limehouse Toll-bar, at which point, turning northwards into Devon's-lane, under the East and West India Dock Railway, and along the Three Mills-lane, it passes under the River Lea, near Three Mills-bridge, to a pumping-station on the eastern side of that river, near Abbey Mills-lane. Here the sewage will be lifted to the high-level sewers by pumping.

The height of the high-level above the low-level sewer being about 35 feet, we consider that engines of about 1700-horse power should be provided for this purpose.

Near to the Stepney Railway Station at Brook-street, this sewer will have a flood outlet into the River Thames, at such a level as will enable the whole of its contents to be discharged at low water, if required upon emergencies.

There are two branches connected with this line. The first commences by a junction with the King's Scholars' Pond Sewer at Besborough-street, Vauxhall, and passes along Millbank and Abingdon street, to a junction with the main line at Parliament-street.

The second branch commences at Ferry-street, in the Isle of Dogs, and passes along the East Ferry-road, Preston New-road, Bow-lane, Catherine-street, and under the Limehouse-cut, to a junction with the main line at Brickfield-lane.

The whole of the foregoing lines converge to the same point on the eastern side of the River Lea; the two high-level sewers having crossed over, and the lower sewer under that river. The sewage of the lower sewer having been lifted to the upper level, the sewage of all three will proceed by three parallel lines in a nearly direct course to the Thames, at the outlet of the River Roding, or Barking Creek, where a reservoir will have to be provided, and means adopted for discharging the accumulated sewage at and near the time of high water.

The reservoir will be about a mile and a-half in length, and about 70 feet wide, forming, in fact, the last mile and a-half of the outlet sewer, enlarged to a capacity sufficient for storing about 7,000,000 cubic feet, or double the average quantity of sewage, which, with an improved water supply, would be produced by the prospective population during the eight hours in which the reservoir outlet would be closed. We assume, that it will be considered necessary to cover this reservoir, and we have designed it with that view, in order to which it has been reduced to the smallest size compatible with effecting the proposed object.

We have considered it better to allow a portion of the rainfall which will be delivered by these sewers to flow into the river on certain occasions,* at all times of tide, rather than to increase the size of the reservoir to such an extent that the enormous expense of the work would probably prevent its being covered.

### IV.—Western District.

The area designated as the Western District comprises about 11,500 acres, or eighteen square miles. It is bounded on the north by the western end of the middle-level intercepting sewer before described; on the south, by the River Thames; on the east by the western limits of the low-level area; and on the west, by Hanwell and Brentford. The general levels of the surface are low, much of it being but slightly above high-water mark, and the remainder rising gradually to its northern margin, at which line it ranges between 50 and 60 feet above Trinity datum.

Nearly the whole of the area may at present be termed suburban in character; there being however, various localities, as Fulham, Brentford, Hammersmith, &c., which are closely built over and populated. As in the other suburban districts, the population is rapidly increasing upon it, and outfall lines of sewer are immediately required for present necessities, as well as for the subsequent extension of the district sewers.

This district extends between six and seven miles west of Chelsea Hospital, the most eastern portion of it being about ten miles from the River Lea. To effect the interception from the Thames of its sewage, by means analagous to those proposed for the general area of the metropolis, would involve, (1) the lifting of the sewage into the main low-level sewer before described, at a point near Chelsea; (2) the conveying of it through the metropolis by that line of sewer (which would have to be correspondingly increased in size through its entire length); and (3) the lifting of it a second time near the River Lea from the great depth to which it would by that time have fallen, to the same level as the higher and gravitating sewers.

The objections to such a course, independently of its immense cost would be considerable, and are such as have induced us to recommend for the Western District the adoption of a system based upon principles entirely different from those which are proposed for the other portions of the metropolis.

Whatever difference of opinion may exist as to the commercial value of sewage water, and the cost of its conversion into dry manure, we believe that experiments already made tend to demonstrate the practicability, not only of abstracting from the water all that is noxious or deleterious, but also of effecting this inoffensively, by works properly constructed.

The cost, though considerable, of establishing and maintaining the works for thus purifying the sewage water of the entire district, and then discharging it into the Thames within the limits of the district itself, would, we are satisfied, after a careful comparison of the probable expense, both original and annual, of the two processes respectively, be less than that of carrying the sewage to Barking Creek. Upon the score therefore of economy alone, even if no other reason existed, we would recommend the former in preference to the latter process, irrespectively of any chance of profits from the manufacture and sale of the manure. It may fairly, however, be anticipated, that means will be shortly developed for effecting the purification of the sewage waters without annual cost to the Commission, and that at a future day this may be made a source of revenue to the ratepayers. The matter has been referred by your honourable Commission to, and is now under the consideration of, a gentleman eminently qualified by his knowledge and experience to pronounce an opinion upon the subject.

In accordance with the views above set forth, our plans for the interception and main drainage of the Western District are designed. The system we propose comprehends two large outfall lines of sewers for the drainage of their respective areas, each with a subsidiary branch, and all converging to a point, at which sewage manure works are proposed to be established, on the banks of the Thames, at the mouth of the Kensington Canal. The main lines will receive the whole of the sewage and drainage of the sub-districts through which they pass, and serve as intercepting lines for conveying the sewage of the entire Western District to the purifying works.

The first of these lines is the Acton line, with a branch from Chelsea; the second, the Brentford line, with a branch from Fulham.

### I.—Acton Line.

This line commences near Acton, in the Uxbridge-road along which it passes to a junction with the Counters' Creek sewer at Royal-crescent. From that point it is proposed to reconstruct the Counters' Creek sewer, enlarging and deepening it, and to continue it as a new and independent outfall into the Thames, near the Kensington Canal.

#### *Chelsea Branch.*

The Chelsea Branch commences at Smith-street, and passes along the King's-road, Cheyne-walk, and Lindley-row to a junction with the Acton Line at Gunter's-grove, King's-road.

### II.—Brentford Line.

The Brentford line commences at the River Brent, near the bridge, and proceeds along the High-street of the town, the Brentford-road, and Turnham-green, where it affords an outfall for the Chiswick drainage; then along King-street, Hammersmith, to a point near Brook-green, where, turning southward through private grounds into the North End-road, it passes on to Walham-green; thence it proceeds along the Fulham-road, down Sand's End-lane, and across Marsh-land to the Thames, on the south side of the Kensington Canal. This line of sewer is provided with auxiliary flood outlets at Brentford and Stamford-brook.

#### *Fulham Branch.*

The Fulham Branch of the Brentford-line commences at Fulham-bridge, and passes along Bridge-street, Church-street, and King's-road, to Parson's-green, and thence to a junction with the Brentford-line at Sand's End-lane.

The outlets for the main lines of the Western Division are at such levels as to admit the discharge of flood waters at half tide. The lift, therefore, required for the sewage water will be only that necessary for raising it into the depositing reservoirs; and

* These occasions are times of heavy rain, not exceeding perhaps twenty-four days in the year.

the subsequent discharge of the purified water can then be effected at any level of tide. The inverts of these sewers are about 18 feet below Trinity high-water mark, and we consider that engines of about 900 horse-power should be provided.

A junction will be effected between the two main lines by a short length of sewer, to convey the sewage to the purifying works.

The marsh lands on the banks of the Thames, near the mouth of, and on the southern side of, the Kensington Canal, appear peculiarly eligible for the establishment of Sewage Manure Works. The land itself is of inferior value, and there are but few habitations in its vicinity; while its proximity to the Thames, to the Canal, and to the West London Railway, would afford great facilities both for bringing materials for the process of deodorisation, purification, &c., and for the economical transit to the markets of the manure when manufactured.

The scheme here proposed for the main drainage of the Western Division is the best which, under present circumstances, it is in our power to offer. But when the result of the inquiry now pending respecting the practicability of effectually dealing with the contents of sewers in the Metropolis shall be ascertained, some considerable modification of this portion of the main drainage scheme may possibly become advisable.

### Estimate.

Our estimate for the whole of the foregoing works upon the northern side of the Thames is as follows:—

| | |
|---|---|
| Northern high level gravitating sewer and branches as given in Report of Mr. Bazalgette . . . | £271,290 |
| Middle level gravitating sewer and branches, including land . . . . . . . . . | 238,000 |
| Main low level line and branches, including land . | 162,400 |
| Extension of high level, middle level, and low level sewers to Barking, including reservoirs, tidal gates, purchase of land, &c. . . . . . . . | 453,500 |
| Pumping engines, pumps, engine houses, &c. . . | 130,000 |
| Western Division, including Acton Line and branch, Brentford Line and branch, land, &c. . . . . | 123,000 |
| Total . . | £1,378,190 |

In our Report upon the scheme of the great London Drainage Company (May 1853), we drew attention to those conditions and requirements which should aid in determining the capacities of sewers having for their object the interception of the sewage from the Thames. We expressed an opinion that they should be adapted not only to the present, but to the future wants of a rapidly increasing population, and that they should be calculated to carry off during a period of six hours one half of the daily sewage discharged.

An examination of the recent Census Tables leads us to the conclusion that, from the manner in which the lines of streets and buildings are now laid out in the suburbs, from the roads being wider, and from there being in most cases yards, gardens, or squares attached to the houses, the average density of the population of those districts, when at its maximum, will not exceed 30,000 inhabitants per square mile. Our calculations of the increase of sewage to be delivered in future years are framed upon this assumption, and in anticipation of an improved water supply equal to five cubic feet per head per diem.

To render complete the interception from the Thames of the London sewage, some provision should be made for carrying off a certain amount of additional flow from the sewers during rains. The washings and scourings from the streets, houses, and sewers, during the first hours of rain, being extremely filthy, we consider that if provision be made for carrying off a depth of 0·25 inches of rain, falling equally in 24 hours, or 0·0104 inches per hour, without making deduction for loss by absorption or evaporation, and in addition to the maximum flow of sewage already calculated upon, the object will be sufficiently realised.

The above conclusions will afford sufficient explanation of the data upon which the sizes of our intercepting sewers are calculated.

The northern high level gravitating sewer, reported upon recently by Mr. Bazalgette, being intended for an intercepting sewer, and at the same time as a main drainage outfall capable of performing all the functions of such a sewer for the district through which it passes, has been calculated to carry off all the sewage as well as all the rain, including storm waters, likely to pass into it from the area drained by it.

The middle level gravitating sewer, and the low level sewer, are calculated to carry off the maximum flow of sewage likely to accrue from the present or prospective population upon the areas draining into them, as well as a rainfall running off equal to a depth of 0·0104 inches per hour. But they will not carry off extraordinary storm waters, with the exception of the western portion of the middle level sewer, which will, as we have before stated, discharge the flood waters received by it into the Ranelagh sewer.

The whole of the sewers designed for the Western Division being intended, in conjunction with the flood outlets, to act as district as well as intercepting sewers, are calculated to carry off the prospective maximum flow of sewage as well as all the rainfall, including storm waters, which they will have to receive.

The sewers from the River Lea to Barking are intended to convey the maximum flow of prospective sewage, and a rainfall running off equal to a depth of 0·0104 inches per hour, over the whole area drained by the northern, middle level, and low level sewers.

In those cases where the main lines are not calculated to receive storm waters, the latter will be carried off either by existing, or by new flood outlets.

In determining the route of the sewers, we have almost entirely kept to the lines of public thoroughfares, and where it has been impracticable to avoid deviating from them, we have selected, as far as possible, such routes as will involve the least outlay for compensation to the owners of property.

With respect to the line of low level sewer, it is desirable that it should be constructed as near the Thames as practicable, both to avoid the public inconvenience, which to some extent must ensue during the construction of the sewer along streets of crowded traffic, and to intercept the sewage at points close to the existing sewer outlets: indeed, had it not been for the much greater cost and engineering difficulties involved, the reasons here stated would have induced us to recommend that the portion of the low level sewer, between Hungerford and London Bridge, should be constructed on the very margin of the Thames, instead of being carried, as we actually propose, along the line of the Strand, &c. If, however, the long contemplated embankment of the Thames between Westminster and London Bridges, which again occupies public attention, should be carried out, much of the cost and difficulty of a river line of sewer would be obviated, and the intercepting sewer might be most advantageously constructed in conjunction with the embankment between Hungerford and London Bridges.

It has been with us an object, as far as practicable, to assign to the whole of the sewers such rates of inclination as would, with their other conditions, insure an uniform velocity of flow through them, sufficient to make them self-cleansing. But the importance of intercepting and delivering by gravitation at high water as much sewage as possible at Barking, so as to perfect above that point the interception from the river of the sewage, has necessitated the reduction of the gradients of the sewers to the minimum, and has, with other considerations of equal importance, necessitated, in some exceptional cases, the reduction of the inclinations below those which we would otherwise wish. But the sewers are, in all such instances, arranged so as to admit of their being cleansed by flushing from existing and available heads of water.

The aim of a system of interception is to discharge the sewage of the metropolis into the river, at such a point, and at such level of the tide, as will prevent its return with the flood tide to the inhabited parts of the town.

The experiments made by the late Mr. F. Forster show, that in order to effect this object, it is necessary to discharge at as remote a point as Barking Creek, and at about high water. We would here observe, that the delivery of the sewage at high water into the river at any point, is equivalent to its discharge at low water at a point twelve miles lower down the river; therefore the construction of twelve miles of sewers is saved by discharging the sewage at high, instead of at low water.

We have already adverted to the question of effectually purifying sewage water without creating a nuisance at the spot where the works are carried on; and we may express a hope, that the time is not far distant, when the manufacture of sewage manure may become a remunerative undertaking. Should this anticipation be realised, then a new consideration, and one seriously affecting the scheme now proposed, immediately arises; namely, whether it would not then be advisable, on the score of economy, to modify considerably the designs here presented for the middle and low level sewers, and to abandon the chief portion of the line between the Lea and Barking Creek, and to establish at suitable spots works for the purification of the sewage water, and for the manufacture of solid manure.

On the other hand, delay is objectionable. Independently of interception, the main drainage of London should be no longer postponed. And assuming that the system of interception must be carried out, so rapidly are the suburban becoming urban districts, that the difficulty and expense consequent upon executing such a work yearly increases: indeed, since 1851, when Mr. F. Forster prepared his scheme, considerable portions of private grounds through which his sewers were intended to pass, and which were then unbuilt upon, are now closely covered with houses and buildings.

In conclusion, we beg to express our belief that the plan we now have the honour of submitting to you will be found to fulfil, as far as practicable, the manifold and various requirements of the large area and population dealt with. But the necessity of considering the question in relation to the existing as well as to the future population; to the wants of districts already densely inhabited, as well as of those which are at present suburban; to the relief required to be provided by new outlet lines of sewers, in addition to those now in existence; to tidal levels; to the existing mass of sewers; to the navigation of tidal channels; and to the fixed and varied levels of railways and roads; together with the present uncertain value of sewage water,—renders difficult the production of a scheme which shall perfectly answer its purpose in all respects, and be economical in first cost, as well as in the charges for maintenance. In preparing this scheme, we have pleasure in acknowledging the information and assistance we have received from the various officers of the Commission throughout our investigations.

J. W. Bazalgette,
*Engineer to the Metropolitan Commission of Sewers.*

William Haywood,
*Engineer to the City Commission of Sewers.*

*Greek-street, Soho, Jan. 21st*, 1854.

*Summary of the Northern Sewage Interception and Drainage.*

| | Area of Districts. | Population. Present Number. | Population. Prospective Number. | Sewage. Per minute, at 5 cubic feet per head per diem. On present Population. | Sewage. Per minute, at 5 cubic feet per head per diem. On prospective Population. | The Maximum flow of Sewage running per minute, during six hours of the day, on the prospective Population. | Rainfall running off per minute, estimated at ¼ inch in 24 Hours. | Rainfall per minute, and maximum Sewage per minute, added together. | Length, Inclination, and Sizes of Outfall Sewers. Length of last or lowest portions. | Rate of Inclination. | Diameter. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Acres. | | | Cubic Feet. | Cubic Feet. | Cubic Feet. | Cubic Feet. | Cubic Feet. | Miles. Ft. | One in | Feet In. |
| Northern High Level Intercepting Sewer, or Hackney Brook ...... | 8,913 | 92,050 | 415,500 | 321 | 1441 | 2882 | 5616 | 8498 | 1 2470 | 1359 | 12 6 |
| Middle Level Line of Sewer, and Branches .................... | 10,260 | 782,200 | 914,500 | 2716 | 3177 | 6354 | 6465 | 12,819 | 1 600 | 2640 | 10 0 |
| Main Low Level Line of Sewer, and Branches .................... | 7,100 | 645,000 | 683,200 | 2240 | 2372 | 4474 | 4474 | 9218 | 0 4100 | 3520 | 9 6 |
| Aggregate ...... | 26,273 | 1,519,250 | 2,013,200 | 5277 | 6990 | 13,980 | 16,555 | 30,535 | | | |
| **WESTERN DIVISION.** | | | | | | | | | | | |
| Brentford Line.......................... | 8,000 | 67,000 | 375,400 | 232 | 1303 | 2606 | 5041 | 7647 | 0 2800 | 2640 | 12 0 |
| Acton and Notting-hill Line ......... | 3,500 | 79,000 | 178,500 | 274 | 616 | 1232 | 2206 | 3438 | 0 1500 | 1495 | 10 0 |
| Aggregate ...... | 11,500 | 146,000 | 553,900 | 506 | 1919 | 3838 | 7247 | 11,085 | | | |

Report *of* Sir William Cubitt *on the Report of* Messrs. Bazalgette *and* Haywood, *on the Lines of Arterial Intercepting Drains on the North side of the River Thames.*

Gentlemen—It now becomes my duty once more to report to you on the Report of the Engineers of the Metropolitan and City Sewers Commissioners respectively; and in the performance of this duty, I have to lament the absence from England of Robert Stephenson, Esq., my colleague in this matter, whose world-wide reputation as a civil engineer, could I but have been favoured with his co-operation in drawing up this Report, would have added much weight to the opinions I have ventured to express.

The Report now under consideration comprises the whole system of the main arterial and intercepting drains on the north side of the Thames, extending from Brentford on the west to Barking Creek on the east,—a distance, in a direct line, of sixteen miles or thereabouts. For the greater portion of this distance, the sewage of the Metropolis on that side the Thames is proposed to be diverted from or rendered innoxious in that river at all times, when not more than one quarter of an inch of rain falls upon the entire district (comprising about 378,000 acres) in 24 hours. When more than that depth falls, which may be on an average 24 days in the year, the dilution of the sewage will be so great, and the scouring effect upon the sewers so useful, that the quantity passing off into the river by the overflow or escape valves will not sensibly or injuriously affect its purity. It would be quite impossible by any known means at *all* times to divert *all* the sewage and surface dirt of the Metropolis from the Thames —a near approximation only can be made to that object.

The districts of the Metropolitan Sewers Commissioners already reported upon, and the cost estimated by Mr. Bazalgette, the Commissioners' Engineer (which Reports were afterwards examined and reported upon by Mr. Stephenson and myself, as Consulting Engineers), were, first: the Northern or Hackney Brook District; the cost of a high-level intercepting sewer for which was estimated by Mr. Bazalgette at 271,290*l*. The plans and details were much approved by Mr. Stephenson and myself, at an amended estimate of 300,000*l*, Secondly: the Surrey and Kent Districts, from Battersea Fields, near the River Wandle, to the Ravensbourne River or Deptford Creek. This comprised, first, a high-level intercepting arterial drain to take off all the rainfall north of the watershed between the Rivers Wandle and Ravensbourne, and to deliver the same into the Thames at Deptford Creek above high-water level, and thus preserve all the southern margin of the river from Battersea to Deptford from being flooded by storm waters; and, secondly, a low level intercepting arterial drain between the high-level drain and the river, to take off both the rain water and the sewage from the insulated strip of land above mentioned. The contents of this would either have to be pumped up, deodorised, and delivered into Deptford Creek, or to be conveyed by an extensive drain or tunnel passing through or near to Greenwich and Woolwich, and receiving the sewage of that district, into Plumstead Marshes, where it would be delivered into the river (either by pumping or alternative reservoirs) opposite to the mouth of Barking Creek—the outlet of all the high and low level intercepting drains on the north of the Thames (with the exception of the Western District, the produce of which it is proposed to deodorise and pass into the Thames at or near the junction of the Kensington Canal therewith; divested of its impurities in the first instance, and taking the chance of obtaining any return by the manufacture of sewage manure).

Reverting again to the Reports of Messrs. Bazalgette and Haywood on the interception or deodorising drainage north of the Thames, I can most unhesitatingly state—after a very careful examination of the reports and plans, and the elaborate set of sections and details which they have produced, together with the estimates founded thereon—that the whole are worthy of every attention, as regards the capacities and inclinations of the various intercepting drains in relation to the quantities of water they have to carry and discharge.

Nevertheless, as works of this kind, from a variety of circumstances which can form no items in an estimate, are seldom or never completed within even the most elaborate calculations that an Engineer is justified in making, I feel bound to state that, although I fully agree with and highly approve the estimate of quantities and probable costs given in the Reports now under consideration, I do not think, even if the funds were at once obtainable, that the whole would or could be carried into effect for the sums stated by the Engineers; and no blame would attach to them on that account; for there is so much disagreement between the fairest estimates and the ultimate cost of public works of this peculiar nature—so many unforeseen items arise—so many inconceivable claims for damages and compensation are preferred, both by public and private individuals, that it is totally impossible for the Engineer of an immense undertaking of this kind to know and clearly foresee all these contingencies and claims; and, could he do so, it would neither be prudent nor, perhaps, even proper to state them, in cases where advantage might be so easily taken both by the public and by contractors, to assist them in making out their claims and estimates.

I have made the above remarks in order to account for the fact that, although I agree with and approve of the mode of carrying into effect the principle (that of interception) upon which the greater portion of these plans are founded (without giving any opinion upon the principle itself), and although I agree with the estimates of the Engineers as being most fair estimates for carrying into effect the works set forth in the Report, plans, and sections, yet I feel it my duty to state distinctly that, in my judgment, the complete establishment of this system of arterial intercepting drains, with all accessories, would not be accomplished for the amounts stated in the various Reports of the Engineers to the Commissioners of Sewers, fair and unassailable though they be.

I shall, therefore, instead of drawing up a longer Report of details upon the various levels, drains, &c., described in Messrs. Bazalgette and Haywood's Report of January 21st, 1854, advise all persons interested in the measure to read that Report, and study the tables and estimates thereto appended, which will well repay the perusal; and shall add an estimate of my own, as to the probable *actual* cost of the works therein described, and also of those proposed for the south side of the Thames, including the extension to the Thames in Plumstead Marshes, of which I have already spoken. This will therefore be my estimate of the total cost of a complete system of Arterial Intercepting Drains for the *whole* Metropolitan district.

*Estimate.*

As to the north of Thames intercepting system, and conveyance down to Barking Creek, instead of a total cost of 1,378,190*l.* as estimated, I am of opinion, for reasons before alluded to in this Report, that the probable cost would be .................. £1,750,000

And as regards the south side of the Thames, say—

| | | |
|---|---|---|
| For the former estimate of Mr. Stephenson and myself, terminating the drainage in Deptford Creek.................................. | £750,000 | |
| Extension of ditto through Greenwich and Woolwich, to an outlet in Plumstead Marshes ........... | 500,000 | 1,250,000 |
| Making a total of ..................... | | £3,000,000 |

to complete the arterial and intercepting drainage of the entire districts north and south of the Thames.

In conclusion, it must be borne in mind, that of the above estimated expenditure of 3,000,000*l.*, the most important and essential parts are in the order in which they should be executed. First, the high-level catch-water intercepting drain on the north of the Thames, which will deliver at all times, the small quantity of sewage and the large and uncertain quantity of storm-water which is produced on an area of 12 square miles, or 7680 acres, between the rivers Wandle and Ravensbourne and the watershed line south, the whole of which would pass into the Thames at all times, at or below high water level, thus relieving from sudden floods of storm-water the whole of Southwark, the waterside premises from Vauxhall Bridge to Deptford, and various portions of Lambeth, Battersea, &c., at the same time rendering it quite possible to drain, by artificial means, the whole of the above-named districts between the high level intercepting drain and the Thames, containing other twelve square miles, which at present cannot be efficiently drained, as almost the entire district lies below the equinoctial tide level, and a great portion of it, the basements of the houses in particular, below even low water level. They are, therefore, subject to be flooded by every high tide or heavy downfall of rain; and when both these casualties occur at the same time, the consequences are lamentable and very destructive, both of human life and property. Second, the work which would meet these difficulties, and might in great measure be carried on concurrently with No. 1, the high level intercepting drain described above, is the low level drain or sewer extending from Battersea Fields to the Ravensbourne, under which it would pass into a pumping station. This, with its branch, would intersect and communicate with all the existing sewers, the present mouths of which in very heavy rains, would serve as safety valves to discharge the storm-waters before they could accumulate and flood the houses of the inhabitants, and engender diseases as at present. But to effect all this, the present outfalls of the sewers would have to be improved and turned into escape valves, shutting out the tides, and the very high tides to be dammed out by raising either the quays or the land a short distance inside the quays.

The above operations are, in my humble opinion, those which require the first attention; and they present this peculiarity, that, to the extent above specified, they must be looked at as a whole, and carried on simultaneously, for no real good can be obtained by attempting to carry them out piecemeal. The portion below, which I have called the Extension Drainage through Greenwich and Woolwich, might stand over for a time; and before entering upon the drainage of the Surrey and Kent districts, down to the Ravensbourne, the way must be seen to the attainment of the 750,000*l.* necessary to its completion, exclusive of any current expenses for local and house drainage. In fact, the great difficulty in my mind relates to the raising of the funds for the execution of the works, which latter might be completed in about two or three years, if set about in earnest, and the quicker they could be carried on the less they would cost.

Pending the decision as to the extension drainage through Greenwich and Woolwich to the Plumstead Marshes, the work of next greatest importance, and one which is within itself and unconnected with others, is the north high level drainage, or the Hackney Brook Sewer, estimated at 300,000*l.*; all the other works on the north of the Thames might then follow in the order stated in the Report of Messrs. Bazalgette and Haywood, of the 21st ultimo.

In making this Report, I have strictly followed what I took to be my instructions, viz., to report upon the Reports of Mr. Bazalgette, and of Messrs. Bazalgette and Haywood, on the construction of Intercepting Sewers, which would divert the sewage of the Metropolis as much as possible from entering the Thames, till it was so far below London that the returning tide would not bring it back again, and this the system proposed by them would certainly accomplish; but to divest the Thames altogether of sewage would be literally impossible, although, no doubt, much may be done to divert the greater portion of it from the river, and to permit none to enter except in a very diluted state. The cost, as stated above, would most probably be 3,000,000*l.* sterling.

6, *Gt. George-street, Westminster,* WILLIAM CUBITT.
*January 25th* 1854.

## ON SMOKE CONSUMPTION.

By C. Guthrie, Birmingham.

All the schemes which have hitherto appeared for purifying the atmosphere of towns seem directed exclusively against smoke production; and although undoubtedly smoke does much mischief to property, health, and beauty, and therefore it would be a great advantage if we could consume it, both as regards economy of fuel and the condition of the atmosphere,—nevertheless, we could not thus attain all that is essential to a pure atmosphere. The gases which are produced by burning coal are not only very injurious to many substances exposed to them, but are even poisonous to all animal life; and it is in vain we procure wholesome food for the stomach, if at the same time the food of the lungs is poisoned. There appears to be nothing which can cause town to be more unhealthy than country but the difference in the purity of the atmosphere: although one great cause of this is imperfect ventilation, still no ventilation can be perfect till we have a source from which we may draw an unlimited supply of pure air. It is desirable, then, on the score of economy, that all the smoke should be consumed; but it is essential that the products of the burnt coal should be altogether removed from our atmosphere.

There appears to be no other way of doing this but by causing these products to ascend very high shafts. This then is the way proposed—the products from each fire passing down flues into mains in the street, and thence into the shaft. The following calculations show that a shaft 600 feet high, and 27 ft. 6 in. clear diameter, with all necessary mains and branch mains, would be sufficient to carry off the smoke from a district extending over four square miles, at a cost of 13*s.* 4*d.* per flue. As 3,600,000 tons of coal are brought to London every year, we may presume that 3,000,000 tons are actually consumed there, which is nearly in the proportion of 500,000 tons for every four square miles. But the shaft must be sufficiently large to carry off the smoke from the coal when at its greatest rate of consumption—say 1,000,000 tons per annum. Now 1,000,000 tons of coal when burnt produce about 12,810,000 tons of gases, for 100 lb. of coal contain about 86 lb. carbon, 5 lb. hydrogen, 5 lb. oxygen, and 4 lb. of ash; and when it is entirely burnt in air, $ON_2$, we get $CO_2$ and $HO$. The atomic weights of these substances are

$$C = 6; \quad H = 1; \quad O = 8; \quad N = 14.$$

Suppose 2 lb. of the oxygen of the coal unite with 2 lb. of the carbon, and the rest of the oxygen with the ash. Then we have 84 lb. of C, which will unite with $14 \times 2 \times 8 = 224$ lb. O, giving 308 lb. $CO_2$, and liberating $14 \times 2 \times 2 \times 14 = 784$ lb. N; altogether $84 + 224 + 784 = 1092$ lb. of gases.

The 5 lb. H will unite with 40 lb. O, producing 45 lb. $HO$, and will liberate 140 lb. N; altogether 185 lb. of gases. Therefore, 100 lb. of coal produce $4 + 1092 + 185 = 1287$ lb., and 1,000,000 tons produce 12,810,000 tons of gases.

We should also have to provide for a quantity of air which would escape into the flues, but this should be reduced as much as possible. The mouths of the flues not in use should therefore be closed; and if each house were taxed according to the quantity of gases passing from it, this might be ensured. Also the mouths of the flues should be placed as near to the fires as convenient.

Suppose then the greatest rate would be $2 \times 12{,}810{,}000$ tons per annum. The specific gravity of $CO_2$ is 1·527, of $HO$ ·624, of N ·972; and for 312 lb. $CO_2$ in the shaft, we have $784 + 140 = 924$ lb. N, 45 lb. $HO$, and $312 + 924 + 45 = 1281$ lb. of air. Therefore the specific gravity of the mixed gases in the shaft

$$= \frac{312 \times 1{\cdot}527 + 924 \times {\cdot}972 + 45 \times {\cdot}624 + 1281}{2 \times 1281} = 1{\cdot}048.$$

One cubic foot of air at 32° weighs about 570 grains. Therefore one cubic foot of the mixed gases at 32° would weigh 597 gr. Suppose that the temperature of the air in the shaft is 80° above that of the external air, which is at 32°. Then since gases at 32° expand $\frac{1}{580}$ of their volume for every degree of temperature, a cubic foot of the mixed gases would weigh $\frac{597 \times 580}{580 + 80} = 524$ gr., and therefore would ascend in air at 32° with a force equal to $570 - 524 = 46$ grains, or $\frac{46}{570}$ of gravity.

This force would produce a velocity of 45 feet per second, for

$$v^2 = 2fs,$$

where $v$ is the velocity sought, $f$ the force producing it, and $s$ the space passed over = about 575 feet. Therefore $v = 55$ feet. But say that the velocity would be 45 feet per second on account of friction. Then the sectional area of the shaft in feet would be equal to

$$\frac{\textit{No. of grs. to be discharged per year}}{\textit{No. of grs. discharged by 1 ft. of shaft}} = \frac{25{,}620{,}000 \times 20 \times 112 \times 16 \times 24 \times 20}{45 \times 60 \times 60 \times 24 \times 365 \times 524} = 593 \text{ ft.}$$

and its diameter 27 ft. 6 in. Each district should be hexagonal in form, and have six main flues, 11 ft. 3 in. diameter, lying in the direction of its shortest diameters. An ordinary house flue would have to be about 1 inch diameter.

To ascertain the cost, suppose that every street main is equal in sectional area to the sum of the sectional areas of the whole of its branches, and that the thickness of the material forming them bears a fixed proportion in all cases to their diameters. It is necessary to find the mean length of the distances of the fires from the shaft in one-sixth of the hexagon, measuring down the centre line and at right angles.

Let $a$ be half the length of the diameter of the area; then

$$\frac{3a \times 2a}{\sqrt{3}} = 4 \text{ miles.} \qquad a = 5670 \text{ feet.}$$

Then we have

$$\text{Mean length} = \frac{\int_a^0 \frac{2x}{\sqrt{3}} \left(x + \frac{x}{2\sqrt{3}}\right)}{\frac{a^2}{\sqrt{3}}} = 4384 \text{ ft.} = 1461 \text{ yds.}$$

The excavation necessary for one yard of the main, 11 ft. 3 in. diameter, would be about 27 yards. Suppose the excavation bears the same relative proportion to all the other mains, then the excavation for all six mains will be $6 \times 27 \times 1461 = 236682$ yards.

Suppose the flues are formed of brickwork, 18 inches thick, then the brickwork in 6 mains $= \frac{6 \times 40 \times 4384}{272} \times \frac{4}{3} = 5157$ rods.

The brickwork in the shaft (620 feet high, 50 feet internal diameter, $7\frac{1}{2}$ bricks thick at bottom, 30 feet internal diameter, and $2\frac{1}{2}$ bricks thick at top) will be $= \frac{5}{3} \times \frac{(176 + 100) \times 620}{272} = 1050$ rods reduced.

The digging for shaft, 63 feet diameter and 21 feet deep, equals $346 \times 7 = 2422$ yards.

The site for the shaft would cost, say, 5500*l.*

Suppose there are 250,000 1-inch house flues, average 8 yards long, = 2,000,000 yards.—So that altogether we have:

| | | | |
|---|---|---|---|
| | 236,682 yds. digging—one-third filling-in and two-thirds carting | @ 2*s.* | £23668 |
| | 5157 rods of brickwork in main flues in street, and labour | @ 10*l.* | 51570 |
| Shaft | 1050 rods brickwork, and hoisting | @ 10*l.* | 10500 |
| | 2422 yds. digging and carting | @ 2*s.* | 242 |
| | Cost of land for site of shaft | say | 5500 |
| | 2,000,000 yds. of inch piping for house-flues and laying in walls | @ 6*d.* | 50000 |
| | 250,000 valves, meters, &c. | @ 2*s.* | 25000 |
| | | Total | £166480 |

Or nearly 13*s.* 4*d.* per flue.

If, instead of having one shaft to every four miles, we had one to every square mile, the cost of the mains and digging for them would be reduced $\sqrt{\frac{1}{4}} = \frac{1}{2}$ per square mile; but the cost of the shaft, with necessary land, &c., would be increased four-fold.

To find what would be the extent of area best adapted to each shaft, we have:

| | |
|---|---|
| Cost per square mile of mains and digging, in the above example | £18809 |
| Ditto ditto of shaft, site, &c. | 4068 |

Let $x$ be the area required, taking four square miles as unity, and $u$ the cost per mile; then

$$u = 18809\sqrt{x} + \frac{4060}{x}$$

$$\frac{du}{dx} = \frac{9404}{\sqrt{x}} - \frac{4060}{x^2} = 0, \text{ when } x \text{ is so taken that } u \text{ is a minimum;}$$

$$\therefore x^3 = \frac{4060^2}{9404^2} = \frac{100}{536}. \qquad x = {\cdot}57 \text{ nearly.}$$

That is, the area ought to be about 2·28 square miles in extent, and the saving per mile would then be

$$22877 - 18809\sqrt{\cdot 57} - \frac{4060}{\cdot 57} = 1527l.$$

The cost per flue would thus be 12*s.* 10*d.*; but this saving would not perhaps compensate for the unsightly appearance of so many shafts.

There would be several advantages in this system besides the purity of the atmosphere, as, for instance—Possessing the power of regulating the draught to any desirable extent, a smoke consuming arrangement might be adapted to ordinary house fires, without materially altering their appearance, and at a trifling cost, thereby effecting a great saving of fuel or heat. The flues might be used as heating pipes before leaving the house, but not so as to reduce the temperature of the shafts too much. There would be a saving in construction and space, as no chimney stacks or breasts would be required, the inch flues being built in the ordinary thickness of the walls. In old buildings the flues are generally arranged in stacks, so that in most cases the new inch flues would be brought down inside them without disturbing much brickwork. The flues would sometimes want clearing; this might be done by firing them, the draught being sufficient to carry off any ash which would result.

## TAPER AND PARALLEL SUSPENSION BRIDGES.

SIR—After seeing the taper principle on which the Balloch and Lochy Bridges are constructed, I took an interest in promoting its adoption in the Aberchalder and in the Ness Island Bridges, which are just finished; and feeling persuaded that an explanation of the principle would not be uninteresting to the readers of your *Journal*, I venture to send it to you for insertion. But before entering upon it, I beg to premise it with a well-authenticated fact, "that it is only by comparison that we can obtain the intrinsic value of things." In attempting it therefore, and in order to bring it home to every one's comprehension, I must put it in juxtaposition with the effects and results of the suspended weight in a bridge on the parallel principle, to those in a bridge on the taper principle, of the same breadth of roadway, span, and deflection, and both having two main chains of the same sectional area and strength at their four respective points of suspension. In the first place, let the deflection of both bridges be $\frac{1}{15}$ of their span, and the suspended weight of the parallel bridge between the points of suspension be 600 tons—*i.e.*, 200 tons the chains and 400 tons the roadway. Then, these being its governing laws, consequently on the chains at the centre the deflection and weight would engender 2250 tons of tension and 562·5 tons at each point of suspension. In operation, truthfully, it is half of the whole weight suspended on the centre of the chains, which is multiplied by half the deflection, and the product is the tension then resulting from these causes. Example: $300 \times 7\cdot5 = 2250 \div 4 = 562\cdot5$. But the usual mode is to multiply the whole suspended weight by one-fourth of the deflection, which produces the same results. Example: $600 \times 3\cdot75 = 2250$ tons.

The roadway in the parallel bridge is only a dead load upon the chains, proportionally producing the same results upon them as their own weight, and therefore I computed the result from the weight of the chains and platform in one sum; but that it might be more clearly understood, I will compute it in the ordinary way separately. Example: 1, weight of chains in tons $200 \times 3\cdot75 = 750$ tons of tension; 2, weight of roadway in tons $400 \times 3\cdot75 = 1500$ tons of tension; and these products are the 2250 tons of tension in the chains at the centre of the bridge, and the 562·5 at each point of suspension resulting from the suspended weight. The results are the same upon the back mooring chains to resist the effects of the suspended weight.

Now, in respect to the taper principle, on the contrary; first, in consequence of each section of the main chains being tapered from its base or main points of suspension to 0 at the centre of the bridge, they would be but half the weight of the parallel main chains, or 100 tons, and this multiplied by one-sixth of the deflection, namely 2·5, the product would be 250 tons of tension resulting from their whole weight, or 62·5 tons at each point of suspension. Example: $100 \times 2\cdot5 = 250 \div 4 = 62\cdot5$. Therefore the economy of iron in the main chains between the points of suspension would be 100 tons, and 100 tons in the back chains, and the reduction of tension at the main points of suspension would be 500 tons, which would be an increase of strength to that extent. But independently of these advantages, the taper principle transfers the horizontal force from the chains to the horizontal line, which effects the same proportional economy of material in the roadway as the taper does in the chains; and besides, it makes the roadway as essential an element of sustentation as that of the chains and the piers, and it secures a rigidity to the bridge that cannot be attained by any other means. The roadway therefore in this instance would be but 200 tons, or twice the weight of the chains, which is the same comparative weight as it is in the parallel bridge. Hence, 200 tons multiplied by 3·75 equals 750 tons of tension resulting from the whole suspended weight of the roadway, and this added to the tension produced by the weight of the chains will be 1000 tons, or 250 at each point of suspension, resulting from the suspended weight.

Here, then, in the parallel bridge, at the main points of suspension, there is 2250 tons of tension resulting from only half the suspended weight, and only 1000 tons in the taper bridge, resulting from the whole suspended weight, which is 1250 tons less in the taper bridge, and consequently this is an increase of strength to that extent; and 1250 divided by 3·75 equals 360 of dead load in tons that the taper bridge would sustain on transit before its chains would be exposed to the same tension as those of the parallel bridge by its weight alone.

Moreover, there are still two other considerable items of difference in these bridges at their main points of suspension, which, for the sake of simplicity, have not yet been alluded to in these definitions:—1. In the parallel bridge there has been but half of the suspended weight taken into account; the other half, or about 300 tons, is direct additional tension at the main points of suspension over and above what has been stated, and consequently this is additional weakness or reduction of strength to that extent. 2. On the contrary, in the taper bridge the diagonals at the piers, in every instance, should sustain one-fourth of the roadway, which is a great object of additional strength that has not been brought into account. Therefore, in round numbers, it may be safely stated, that in this instance the taper bridge for traffic purposes would be more than 500 tons stronger than the parallel bridge. And further, it may be stated that at the centre of the taper bridge there is neither weight nor tension on the chains, because they are connected only through the medium of the horizontal line; therefore both weight and tension become evanescent at this point, and from it as the chains progressively increase in section, and therefore in strength, to their points of suspension, the weight, and consequent tension, increase in the same proportion progressively upon the main chains, and the effect of transit loads operate upon them in the same way.

The superiority of the taper principle, as shown in this instance, is more and more immense as the magnitude of bridges is increased, and proportionally less in smaller bridges, because it springs from three great causes:—First, *from the reduction of half the suspended weight in every instance;* secondly, *from the centre of gravity in the taper chain being one-sixth of its length nearer the point of suspension than it is in the parallel chain;* and thirdly, *from the transfer of the horizontal force from the chains to the horizontal line, which thereby transmutes one of its most destructive elements into one of the strongest supports in a bridge.*

The horizontal force in the chains at the centre of the parallel bridge (2250 tons) is that strain or tension which naturally arises in the formation and maintenance of the bridge, and the effect of it is always directly as the deflection, and inversely as the span existing upon the centre of the curve; that is, half of the suspended weight multiplied by half the deflection. But in the taper bridge this force is sustained by the roadway, and therefore it may be truly said, that whilst the parallel chains have to sustain themselves, the roadway, and load too in the weakest of all positions, the roadway of the taper bridge, in combination, sustains the chains, itself, and the load too in that position. And this is the great mechanical difference in the two principles.

In respect to the economy of material in the roadway, which in principle is neither more nor less than a long beam, and the fundamental law of which is, that when the beam is tied at both ends it will sustain twice the weight it will bear when both the ends are loose. Therefore the same rule holds good in bridges; and as the roadway of the bridge is only hanging neutrally upon the chains, whilst in the taper bridge it is full of equidistant horizontal ties from end to end, and as active as the chains, one-half of the material is fully its own weight stronger in consequence.

*Bath, March 24th* 1854. A LOVER OF MECHANICS.

## DRAINAGE AND WATER SUPPLY.*

*(Concluded from page 128.)*

### Tottenham Drainage.

The general surface of the ground at Tottenham has a gentle fall towards the valley of the River Lea. The subsoil of the northern portion of the town is gravel, and of the southern portion London clay. Its surface and subsoil drainage was provided for by brick sewers, which have been many years constructed, and which are still maintained for this purpose. The house drainage was conveyed into cesspools with overflows into the adjoining sewers or ditches.

In May 1849, Mr. W. Ranger, one of the Inspectors of the General Board of Health, made his Report to that Board upon Tottenham, and a rated district was formed, containing 2000 houses and a population of 11,000 persons, with a Local Board of Health. The plans of their engineer, Mr. J. Pilbrow, for the water supply and house drainage of the town were submitted for the approval of the General Board on October 1st, 1850, and received its sanction on the 22nd August 1851.

Here, as elsewhere, the new sewers are divided into two classes,—public sewers executed at the public cost, and private sewers (including also house drains) executed at private cost.

The public works of a portion of the district were completed about September 1852. The private works or house drainage commenced about that time, and the number of houses connected with the sewers was, in February last, about 400; in August last, about 1100; and at the present time, 1800; so that, in point of fact, Tottenham does not afford a longer experience of the working of this system of sewerage than the other places which I have lately visited.

The works, with a few exceptions, have been executed as originally designed by Mr. Pilbrow; and the only alteration of importance which he was required to make by the General Board of Health was, the reduction in diameter of his outlet sewer from 21 to 18 inches; but as the drainage of the district is rapidly extending, there are good grounds for believing that the outlet will have to be taken up, and a brick sewer of larger dimensions substituted for it.

The main sewers are laid generally under the footpaths of the public thoroughfares, and vary from 7½ inches to 18 inches in diameter; but Mr. Pilbrow would not again use pipe sewers larger than 15 inches in diameter, and those only under peculiar circumstances; beyond that size he prefers brick sewers, upon the score of both economy and efficiency.

The inclinations of some of the main lines are flat; for instance, commencing with the outfall and going upwards they are as follows:—

| Diameter of Pipe. | Rate of Fall. |
|---|---|
| 18 inches | 1 in 1062 to 1 in 659 |
| 15 inches | 1 in 635 |
| 12 inches | 1 in 635 |
| 9 inches | 1 in 340 |

The greatest depth below the surface at which these sewers are laid is 13 feet, and the average depth is about 7 to 8 feet.

The pipes are circular stoneware socket pipes, formed with a bell mouth, so as to prevent the shoulder of one pipe projecting beyond the adjoining pipe, in case of any settlement of the ground; and this appears to me a decided improvement on the usual form. The joints are made with Portland cement, and Mr. Pilbrow attaches great importance to this mode of jointing, because Portland cement, taking a long time to set, to some extent adapts itself to any settlement of the pipes which may happen while the ground is soft.

Flushing-shafts have been constructed at the heads of the branch sewers, which are flushed out every two or three months; and there are four man-holes or shafts constructed for the purpose of inspecting the pipes; but they show the condition of the pipes only at those particular points at which they are fixed, and are no indication of their condition at any other points.

Provision for the ventilation of the sewers has been made by connecting the stack pipes of the houses with the sewers, or by carrying up a shaft in the centre of a garden-wall unknown to the owner, or where the sewer crosses a field, carrying up pipes by the side of trees; indeed, when sewers are constructed in districts not closely peopled, many opportunities of obtaining ventilation present themselves which are not to be found in a crowded city.

The surface drainage has not been admitted into the sewers, and Mr. Pilbrow expresses a very decided opinion, that if it were admitted they would very soon become entirely choked up.

The outfall is at present into the Mosell, and thence into the River Lea, the water of which is supplied below this point by the East London Waterworks Company to the London consumers, upon whom a great evil is thus inflicted. The Local Board are alive to this point, have purchased land for the construction of sewage works, and are now in treaty with a contractor for undertaking, free of cost to the Board, the purification of the sewage, of which he is to have the free use for twenty-one years. The process of precipitation proposed to be adopted is known as Higgs' process, now used at Cardiff jail. If the agreement renders compulsory, under penalties, the purification of the sewage at all times, and this obligation be strictly enforced, the result promises to be satisfactory.

Back combined drainage has been generally adopted for the private sewers and house drains. The latter vary in diameter from 4 to 6 inches, and their average inclination is about 1 in 50 or 60. In some cases the 6-inch pipes have been laid down for a length of 600 or 700 feet at an inclination of 1 in 200; but I am informed that no stoppages or breakages have yet taken place.

The cost of the private works is said to average about 8*l.* per house; but they have in some instances amounted to 60*l.* or 70*l.*

The water is obtained from two bore holes, one of 12-inch bore sunk 100 feet into the chalk, and one of 10-inch bore sunk through the gravel to the surface of the chalk. The water from these flows into a subterranean reservoir, whence it is raised by two 6-horse engines to a reservoir 100 feet above the town, capable of containing 100,000 gallons, or barely one day's supply. A further quantity of water, about equal in amount, gains admittance into the sewers from springs in the gravel; so that, on the average, about 200,000 gallons of water are passed daily through the sewers. The supply pipes to the houses vary from 1 inch to ¾-inch, and the water is laid on upon the system of constant supply; but Mr. Pilbrow's arrangements in this respect, as in many other details, are superior to those in any of the other towns included in this Report, and it is only due to him to state, that they exclusively originate with himself.

Mr. Pilbrow has invented what he terms a "Preventor," consisting of a stone or gutta-percha ball, which, when a tap is opened, is forced up with the rising stream of water, and stops the orifice after about a pail-full of water has passed through it; and the ball will not then admit of any more water passing until the tap has been turned back and the ball allowed again to fall to the bottom of the chamber. This simple apparatus prevents the great waste of water which is complained of in other places where the constant supply system has been adopted; and the quantity and force of the flush of water here used are vastly superior to what I have witnessed elsewhere, and tend materially to mitigate the evils attendant upon too extensive an application of small pipes.

| | |
|---|---|
| The cost of public works, irrespective of extensions, which will hereafter become necessary, and irrespective also of the preliminary inquiry, survey, &c., have amounted to ... | £10,000 |
| The private works, taken at an average of 8*l.* per house, would amount to ........ | 16,000 |
| Total ........ | £26,000 |

The public works at Tottenham were executed at very low prices; they could not now be done for the same money; but they could always be done at a very much less cost there than in the streets of London.

The following give a fair average of the contract prices at which these works were executed, the greater portion of the sewers being laid under the footpaths. When laid under roads they cost rather more, and when in fields rather less.

Pipes laid in footpaths and courtyards, every expense included, except the cost of the pipes:—

| Diameter of Pipe. | 6 ft. Depth. s. d. | 8 ft. Depth. s. d. | 10 ft. Depth. s. d. |
|---|---|---|---|
| 6 inches | 0 8¼ | 0 11 | 1 0 |
| 9 inches | 0 9¼ | 1 2¼ | 1 3½ |
| 12 inches | 0 11¼ | 1 3¼ | 1 7¼ |

The rateable value of the property in this district is about

* 'Report upon the Drainage and Water Supply of Rugby, Sandgate, Tottenham, St. Thomas's, Exeter, and Barnard Castle.' By J. W. Bazalgette, Esq. Engineer to the Metropolitan Commission of Sewers. Published by Authority: 1854.

25,000*l*. A special rate of 4½*d*. is raised to pay off the principal and interest for the public works, and a general district rate of 2*d*. to pay salaries. No provision is at present made for repairs to these sewers, inasmuch as the contractor is bound to execute all repairs for the next five years. The general district rate was formerly 5*d*., in order to cover the payment for the survey and preliminary expenses. The water-rate appears to be about 3½*d*. in the pound, varying slightly with different houses.

### St. Thomas, Exeter, Drainage.

The rated district of St. Thomas is situated on the banks of the river Exe, opposite to the city of Exeter. The greater part of it is rural. The town portion consists (1), of the town of St. Thomas, forming the south-western suburb of Exeter, and containing 598 houses; and (2), of the village or hamlet of Exwick, containing 80 houses, about a mile to the north of St. Thomas, on the banks of the Exe. Exwick is drained into that river above Exeter. The population of the whole district is about 6000. The subsoil, to the depth at which the sewers are laid, is clean river gravel and shingle, showing, from their appearance, that the lower parts of the district were at one period washed by tidal waters. The surface of the ground at St. Thomas, near the river is low and flat, whilst that of Exwick has a rapid fall towards the river.

Before the new works were contemplated, the surface drainage was provided for by means of some old brick sewers and cesspools, into which the water was allowed to flow, from considerable distances, over the pathways, and along the surface of the streets. These old sewers and cesspools still exist; and in addition thereto, thirty-one new gullies have been connected with the new sewers, but the rain water is still allowed to run from the roofs of the houses over the footways and along the street gutters, and in this respect the surface drainage is still very defective.

The gravel upon which the houses are built is in itself a natural drain, and mere holes or pits in the ground would convey the liquid refuse of the town into the gravel, whence it would filter without artificial means down to the level of the river Exe.

The preliminary Report upon St. Thomas was made to the General Board of Health, by Mr. G. T. Clarke, one of their Inspectors, in April 1849.

The public sewers of St. Thomas were designed by and executed under Messrs. Dymond and Sons, and they were completed in August 1851. They consist of stoneware socket pipes of London manufacture, varying in diameter from 4 to 18 inches, and in inclination from 1 in 22 to 1 in 1000. Their average depth below the surface is only 5 feet, and they are laid in a gravel soil. The main lines are constructed generally either along the roads or across fields.

The 18-inch and 15-inch pipes, comprising the outlet sewers of the suburb of St. Thomas (which are laid at the flattest inclinations), are almost entirely outside the town; and they are flushed frequently from three places constructed for that purpose. Usually they have a considerable stream of water passing through them. With respect to the main body of the sewers in the town itself, which are of smaller dimensions, no means exist of either examining or flushing any of them. And as they have not been inspected since they were laid down, the present condition of the sewers in the town itself must be unknown, because (for the reasons more fully given in the Report upon the sewers at Sandgate) when stoppages occur in pipes laid in sand or gravel, the soil receives and discharges the sewage which the pipes cannot convey away, and so the stoppage is not discovered until some accidental circumstance draws attention to it.

The main outfall sewer consists of an 18-inch pipe, which is carried across the fields by the side of the South Devon Railway, for a distance of about a quarter of a mile; it then enters and passes through a brick chamber, and discharges into a large shallow pond of filth, constituting a wide-spreading open cesspool at the foot of the railway embankment. The overflow from this pond is into an adjoining stream of water, running by the side of the railway. The pond here described exposes a large evaporating surface of the most disgusting kind, and some means should be immediately taken for its purification or removal. The brick chamber through which the sewage passes is divided into two or three small settling reservoirs, which were no doubt intended to receive the sewage. A man comes down occasionally to try various means of saving the manure, and two or three small heaps were pointed out as having been collected by him, but none of these have as yet been used upon the land, although the sum of 20*l*. per annum is paid for the use of the town sewage. It would thus appear that the works for manure operations, constructed at this point at a cost (including the land) of 700*l*., have not, up to the present time, been of any practical utility.

There are from twenty to thirty of the houses in the suburb of St. Thomas which are not connected with the above system of sewers, but have separate lines of pipes with outfalls direct into the River Exe, opposite to Exeter.

The public sewers of the hamlet of Exwick vary from 4 to 9 inches in diameter, and their inclination from 1 to 7 to 1 in 100. There are two separate 9-inch outfall pipes, which discharge into a mill-stream, and thence into the River Exe, about a mile above Exeter.

No provision has been made as a general rule, either in St. Thomas's or in Exwick, for the ventilation of the pipe sewers; as an exception to this observation, in two or three instances the waterspouts from the roofs of the houses have been connected with the upper ends of the pipe sewers, for the purpose of ventilating the latter.

It is stated that none of the pipes have broken since they were laid down; but a general examination of the sewers, or longer experience, is requisite to elicit the fact.

The house drainage may be considered to have commenced in August 1851; and in March last there were in St. Thomas's and Exwick together, 402 houses drained into the sewers; in September last, 580; and at the present time 640. But this statement requires closer examination.

To a large extent there is but one watercloset for two or three houses. In particular, one block of 21 houses was pointed out which have only seven waterclosets amongst them; so that here, in point of fact, No. 1 is drained, and has water and a watercloset; whilst Nos. 2 and 3 are undrained, but the inmates are allowed to avail themselves of the drainage provided for No. 1. Now, the Report of Messrs. Dymond would lead to the supposition that Nos. 1, 2, and 3 have all been drained; whilst, in fact, the cost of the drainage of the one house has been divided amongst the three, to give the average cost of draining each house.

Mr. Bazalgette estimates that there is, upon the average, about one watercloset to two houses throughout the district. If, then, from 678—the total number of houses in the district—are deducted 80 which belong to the hamlet of Exwick, and are drained by distinct sewers, 38 not yet drained, and 25 which drain by separate outfalls into the river, and assume that the remaining 535 have waterclosets at the rate of one to every two houses, and if it is to be understood that a single connected system of sewers is spoken of, we should have 267 instead of 640 waterclosets now draining through the main system of pipes into the open cesspool near the railway; 243 instead of 580 so draining in September last; and 168 instead of 402 in March last. The remainder discharge by separate sewers into the River Exe, or the houses are yet undrained. Thus, upon consideration, it appears that St. Thomas's does not afford the experience as to amount of drainage by pipe sewers, which, from the statements respecting it, it would seem to do.

The private sewers and house drains vary in diameter from 4 to 9 inches; the former size is used for a single house. The average inclination is from 1 in 25 to 1 in 30.

Combined and back drainage has been generally adopted. When the owners of houses were willing to combine in the execution of the minor branches through their property, and at their own cost, they constructed such branches as private works; but when they were unwilling to do so, or objected to their property being intersected by their neighbours' drains, the Local Board, out of the public funds, carried up the branch sewers to the last house in the line, so that there was a strong inducement to all parties not to agree to construct combined works at their own individual cost, but to oblige the Local Board to carry those works out at the cost of the public. There are said to have been about a dozen stoppages discovered in the house drains, from the introduction of improper substances, such as flannel, rags, straw, &c.

The actual cost of the work, as given in the letter of Messrs. Dymond to Lord Palmerston, exclusive of any of these charges, is set down at 2371*l*. The average cost of the private works is stated to be 4*l*. 2*s*. 6*d*. per house; but it must be borne in mind that this sum does not represent the actual cost of the drainage works for each house actually drained. If the averages assumed above, of one watercloset to two houses, be correct, the cost of private works for draining each house would be 8*l.* 5*s.*, exclusive of supervision. Therefore, assuming in the first place, the present defective provision of one watercloset to two houses to be completed and continued—

| | |
|---|---|
| The cost for private works would be .................. | £2796 |
| The cost for public sewers .............................. | 2371 |
| Total ............... ........... | £5167 |

And in the absence of more definite information, and reasoning from analogy, as in the case of the other towns, the cost of surveys, supervision, &c., would increase the above amount to from 6000*l.* to 7000*l.* If, on the other hand, a watercloset were provided and water laid on to every house—

| | |
|---|---|
| The private works would amount to .................. | £5593 |
| Public sewers.................................................. | 2371 |
| Total ...................... | £7964 |

And the surveys and supervisions, &c., would make the total cost somewhere between 9000*l.* and 10,000*l.* These estimates are exclusive of the public works for the supply of water, and for the removal of rain water from the surface of the footways, or for any improvement of the outfall. The prices at which the works were executed were as follows:—

Excavation and laying pipes, filling-in, strutting, shoring, carting away superfluous earth, including all expenses, excepting the cost of the pipes—

| | | | | | Per foot lineal. |
|---|---|---|---|---|---|
| 6-inch pipes, average depth being 3 to 4 ft. | | | | ......... | 5*d.* |
| 9-inch | ,, | ,, | ,, ditto. | ......... | 5*d.* |
| 12-inch | ,, | ,, | ,, 5 ft. | ......... | 8*d.* |
| 15-inch | ,, | ,, | ,, ditto | ......... | 9*d.* |
| 18-inch | ,, | ,, | ,, ditto | ......... | 11*d.* |

An additional price of 2*d.* per foot lineal was paid for removing and relaying pitching; 4*d.* per foot lineal for macadamised roads; and 6*d.* per foot lineal for pavements. Most of the footpaths are made with round-stone pitching, and there is but little pavement in the place.

The rateable value of the houses in St. Thomas's is about 5000*l.*, the rateable value of the whole district being about 11,000*l.* A special district rate of 7*d.* in the pound per annum upon houses, and 1¾*d.* upon land, is raised for the repayment of the money borrowed. A general district rate of 10*d.* in the pound is raised to cover supervision, repairs, &c.; or, in its stead, a highway rate of 4*d.*, together with a general district rate of 6*d.* The water rate amounts to 10*d.* in the pound, and 1½*d.* in the pound for public purposes.

The Exeter Waterworks Company provide St. Thomas's with water upon the system of constant supply. It is obtained from the River Pynes, a branch of the Exe and Culm, about four miles above Exeter. The reservoir is 170 feet above St Thomas's, and the Company are now extending their works. The Superintendent, under Mr. Simpson, Engineer of the Company, states, that "the supply of water from the Exeter Works to the district of St. Thomas, as near as it can be ascertained, usually exceeds an average of 120 gallons per house per diem. "In dry weather the gutters are washed occasionally by allowing the water to run from the waterworks' plug for about fifteen minutes each time. The pipe drains do not at present extend to the whole of the district, but there is a great waste of water, which no doubt tends materially to cleanse them. The pipe drains have not been down a sufficient length of time to ascertain any practical result as to stoppages or otherwise which ought to be relied on."

Mr. Bazalgette's visit to St. Thomas's was made on the 1st of February 1854. He considers the arrangements for its drainage still far from being perfect and complete; and that they do not afford sufficient experience of the success or failure of such an application of pipe drainage.

### Barnard Castle Drainage.

Barnard Castle is a small, quiet country town, containing about 4600 inhabitants and 700 houses. It is situated upon the side of a hill, having a precipitous fall towards the banks of the River Tees.

The town drainage is divided into two separate and distinct systems of sewers:—1, those sewers originally provided to carry off the road and surface drainage; 2, another system of sewers recently provided under the General Board of Health, to carry off the house drainage. The latter are again subdivided into public and private sewers. Of the entire number of sewers and drains for house drainage laid down upon the Engineer's plan, extending, in the aggregate, to a length of about eight miles, four and a-half miles, or thereabouts, in length, are marked as public sewers; whilst the remaining three and a-half miles, constituting the private sewers and drains, either have been or will be executed out of the private funds of the individuals required to construct them.

The public sewers and the main lines for the supply of water were designed and executed under the direction of Mr. Ranger, the Inspector of the General Board of Health, who had, in November 1848, made the preliminary inquiry into the sanitary state of the town and its drainage, and who was afterwards appointed the Engineer to the Local Board; and they were constructed under the immediate supervision of his assistant, Mr. A. Morgan. These public works were completed in April 1852. From that date, the drainage of the town may, with but few exceptions, be considered to have commenced; because, until the house drainage was conveyed into the sewers, the latter remained inoperative, and only came into action in proportion as the private works progressed. Towards and since the completion of the public sewers, the Local Board, as far as practicable, have from time to time required the owners of the houses, at their own cost, to destroy their cesspools, put up waterclosets, lay on water, and construct drains and private sewers from their houses to the public sewers. But inasmuch as these proceedings have in many cases given rise to much opposition, the Local Board have found it necessary to proceed slowly, and with much caution and forbearance. About rather more than one-half of the houses have up to the present time been connected with the public sewers.

The road and surface drainage continues to be carried off by the previously existing brick drains; and only house drainage and the rain from the roofs is allowed to be conveyed into the pipe sewers. The pipe sewers and drains vary in size from 4 to 15 inches in diameter. The following table gives the length and sizes of the public sewers:—

| Diameter of Pipes in Inches. | 15 | 12 | 10 | 9 | 8 | 6 | 4 |
|---|---|---|---|---|---|---|---|
| Length in Feet ... | 500 ... | 800 ... | 645 ... | 635 ... | 2366 ... | 14,417 ... | 5104 |
| Total ................. 24,467 | | | | | | | |

The natural levels of the surface have afforded such favourable inclinations as can be obtained in but very few other towns in this country. They range from 1 in 5 to 1 in 200, the average or ruling gradient being about 1 in 30.

The pipes used have socket joints, and they are mainly of fireclay from the neighbourhood of Manchester and Leeds, but some few are stoneware, from London. The joints are formed with cement, great care being taken to make them water-tight. No provision has been made for the ventilation of the sewers or drains. The sewers have been laid at the backs of the houses or under the side channels of the streets, at an average depth of from 8 to 10 feet below the surface, and they are subjected to little or no traffic over them.

There have been but three or four stoppages in the pipes. Indeed, considering the extraordinary falls above named, the small amount of drainage received, and the facility that exists of passing, at any time, a rapid stream of water through the sewers and drains, it would, with moderate-sized pipes, be surprising were it otherwise. The stoppages alluded to are stated to have been occasioned by imperfectly-formed junctions or other avoidable causes. In one instance however, viz., a 6-inch branch pipe laid near Thorngate, at an inclination of 1 in 200, and receiving the drainage from eight waterclosets, stoppages occurred, requiring a considerable length of pipe to be broken up; and the surveyor has reason to believe that deposit is again accumulating in it, and that in order to make it efficient, it will have to be detached from the main line, and reconstructed with a discharge into the River Tees, at a nearer point, so as to obtain a better fall. Another cause of stoppage, occurring in a private drain, arose from the joints not having been made water-tight, so that the water escaped through them into the soil, leaving the deposit to accumulate and cause a stoppage in the drain.

The surveyor is of opinion, derived from experience, that the successful working of pipe sewers is essentially dependent upon perfect workmanship and water-tight joints, with an abundant supply of water, and the exclusion of surface drainage coming from the roads.

The supply of water for the town is obtained from Stoney Keld Springs, distant about six miles; it is conveyed thence, by gravitation, through 9-inch stoneware pipes, for a distance of four miles, to a reservoir about 100 feet above the level of the centre portion of the town, and capable of holding about 20,000 gallons; but this reservoir is too small for the wants of the town, and will shortly have to be enlarged. The supply pipe from the reservoir into the town is an iron pipe, 7 inches in diameter. The system of constant supply is here adopted; but some inconvenience has been felt from the waste occasioned by careless persons and children leaving the taps open, by which, upon one or two occasions, the reservoir was emptied in the course of the night. The fire-plugs are opened, and the water allowed to flow through the sewers for about a quarter of an hour once a week, in order to cleanse them.

At the time when Mr. Bazalgette inspected these works, he found many of the waterclosets and water-pipes frozen up and inoperative; arising in several instances from the owners having laid the drains and pipes too near the surface, in order to save the expense of excavation. Some of the householders have excavated the ground for themselves, only 9 or 10 inches deep, and employed a bricklayer only to lay the pipes, doing the rest themselves. The works in this case will have to be reconstructed. The cost of the private works was stated to have amounted to about 5*l.* per house on the average, which, upon 700 houses, would amount in the whole to about 3500*l.*; but in many instances there is but one watercloset to three or four houses. This sum does not therefore represent the actual cost of draining each house, but it gives the cost of these works reduced, by being divided amongst a larger number of houses.

The cost of the works termed "public works" was, for water supply 4000*l.*, and for public sewers 2000*l.*; those sums include the engineer's professional charge of 397*l.*, and all other charges for supervision, but they are exclusive of the cost of the survey (which is not yet paid), and the preliminary inquiry of and reports by Mr. Ranger. Taking into account these additional items, the cost of the house drainage and water supply of this town will, when completed, amount to a sum of, probably, 10,000*l.*; but this, it must be borne in mind, is irrespective of the cost of the sewers for surface and subsoil drainage, and of the proposed enlargement of the reservoirs. The estimate would stand thus:—

| | |
|---|---|
| Waterworks | £4000 |
| Public Sewers | 2000 |
| Private Works (upon reduced estimate by being divided amongst a larger number of houses) | 3500 |
| Survey and preliminary inquiry, &c., say | 500 |
| Total | £10,000 |

The rateable value of the property included in the district rated to the works here described is about 6000*l.*, and a rate of 1*s.* 6*d.* in the pound per annum is charged upon the whole of the property in respect of the public works, in addition to a charge of 2*d.* in the pound per annum for private water supply to all consumers. The charges for supervision, maintenance, and repairs, of the double system of pipe and surface drainage sewers, are paid for out of a rate called the "General District Rate," amounting to 4*d.* in the pound.

As the local circumstances under which drainage works are constructed vary so considerably, it would be perfectly idle to institute a comparison, either as to cost or in any other respect, between the drainage of two distinct places, without a full consideration of the circumstances applicable to each. And this observation applies with peculiar force where an attempt is made to compare the drainage of a great city like London with that of a small town or village in a distant province or in a rural district. The nature of the soil and surface; the nature and quality of the roads; the amount of traffic over them; the weight and proximity of the buildings; the existence or non-existence of cellars under the houses and streets; the rate of wages; and a variety of other circumstances, must not only govern the kind of structure best adapted to the locality, but will also have a material influence upon its cost and the difficulty of its execution. One very heavy item in London, which has scarcely a parallel in a small country town, consists in the cost of strutting, shoring, lighting, fencing, and watching, and taking those other necessary precautions against accidents and danger to buildings and the inhabitants, as well as to passengers in the streets, which are indispensable in a large and crowded city with enormous traffic. By way of illustration, I may mention, that the contract prices - laying 6, 9, and 12 inch pipes, at the depths of 6 and 10 feet respectively, exclusive of the cost of the pipes, are as follows, in London and at Barnard Castle:—

*Comparative Cost of similar Work at London and Barnard Castle.*

| Diameter of Pipe. | Depth laid. | Cost, per Yard lineal. At London. | Cost, per Yard lineal. Barnard Castle. | Excess of Cost for similar Description of Work in London over Barnard Castle. |
|---|---|---|---|---|
| Inches. | Feet. | *s.* *d.* | *s.* *d.* *s.* *d.* | *s.* *d.* *s.* *d.* |
| 6 | 6 | 2 3 | 0 8 to 0 9 | 1 7 to 1 6 |
| ... | 10 | 3 10½ | 1 6 to 1 8 | 2 4½ to 2 2½ |
| 9 | 6 | 2 4½ | 0 8½ to 0 10½ | 1 8 to 1 6 |
| ... | 10 | 4 0 | 1 6¼ to 1 9 | 2 5¾ to 2 3 |
| 12 | 6 | 2 4½ | 0 9¾ to 0 10½ | 1 6¾ to 1 6 |
| ... | 10 | 4 0 | 1 8¼ to 1 10½ | 2 3¾ to 2 1½ |

Now, in London, the cost of merely relaying the pavement would amount to from 1*s.* to 1*s.* 10*d.* per yard lineal, which in most cases exceeds the whole cost per yard of laying the sewers at Barnard Castle, exclusive of the material. But it is also the fact, that the average depths of sewers in London is of necessity nearly double that of the sewers in our country towns and villages.

### Concluding Remarks.

As much misapprehension exists upon the relative value of pipe sewers as compared with brick sewers, Mr. Bazalgette, in his concluding remarks to his Report, touches upon the few simple reasons which render brick sewers of the form now generally adopted in London preferable, as a rule, to pipe sewers for the drainage of large towns. The rule upon this, as upon almost every other subject, must of course be open to occasional exceptions. Every one acquainted, however slightly, with hydraulic engineering, knows that the rapid conveyance of a fluid is essentially promoted by a smooth bore, and a channel so circumscribed as to present the least possible frictional surface, as compared with the sectional area of the fluid. It cannot be denied that these conditions are fulfilled *in each separate length* of a properly-made glazed stoneware pipe, of a diameter proportioned to the quantity of fluid to be discharged. Nevertheless, in town drainage there are other considerations of no less moment which often compel the engineer to forego an advantage in one direction to secure equal or greater advantages in another. This will appear when we consider the complex duty to be discharged by the sewers of a large town. Such sewers have to provide for three distinct objects—house drainage, subsoil drainage, and surface drainage. The house drainage may be considered as tolerably uniform in quantity, and the subsoil drainage nearly so. But the quantity of the surface drainage is very variable,—in times of heavy rain greatly exceeding the average quantity, and demanding a proportionate provision to meet such extraordinary exigencies.

Now, pipe sewers, though adapted for house drainage under the conditions already mentioned, are not adapted simultaneously either for subsoil or for surface drainage. When therefore in a large town pipe sewers are laid down for house drainage, the subsoil and the surface drainage must be provided for by a second system of sewers as numerous at least as the others, and of larger dimensions. It is therefore a manifest fallacy to compare, either in cost or otherwise, pipe sewers performing a single duty, with brick sewers performing a triple duty. The comparison to be worth anything, should be instituted between the double system of sewer required under the one practice, with the single system, which suffices in the other. On the other hand, the London egg-shaped sewers are admirably adapted to answer the triple purpose adverted to.

It thus appears, that (with the ordinary flow) the sewage runs through an 18-inch channel, differing (so far as the part of the sewer actually in use is concerned) in no respect from an 18-inch pipe sewer, except that it is made of hard brick instead of glazed stoneware.

The only supposable disadvantage attending the brick sewer is in respect of smoothness, and this is more imaginary than real. The pipe sewer, it is urged, has a glazed surface, whilst that of the brick sewer is comparatively rough, and the joints in the latter are much more numerous than in the former. But experience proves that greater nicety is practically attainable in laying the bricks true than in jointing the pipes; and the inequalities in the joints of the latter, though much fewer in number, cause stoppages more readily than the more numerous but smaller inequalites in the joints of the brickwork. Again after a short time, the surface of brick sewers and pipe sewers alike becomes coated with a slimy substance, and practically reduces them to an equality in respect of smoothness.

By here and there laying a few bricks dry (or some equivalent device) at or about the level of the springing of the crown, admission is given to the subsoil drainage far above the level of the ordinary flow of sewage, without at the same time permitting the sewage to escape and saturate the soil.

It is evident, that the enlarged upper portion of the sewer provides amply, and with considerable hydraulic advantage in point of form, for extraordinary accessions of storm-water. Should any of the numerous substances (such as rags, flannels, straw, scrubbing-brushes, nightcaps, kittens, &c.), which cause such serious and often insurmountable obstructions to pipe sewers, get into a brick sewer of the kind here described, so as to block up the ordinary channel, there would still be room enough above for the sewage to pass over them; and (if not removed in the meantime by flushing or manual labour) the powerful force exerted by the next storm would wash them to the outlet.

It is needless to dwell upon the great advantage of the large space afforded by the size of the sewer for workmen to enter it for cleansing or repairing it, for removing obstructions, and for remedying any derangement of the house drains running into it, without the costly expedient of breaking up the street and interfering with the traffic.

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Appended to Mr. Bazalgette's Report are the respective Reports of the Local Boards of Health of the places to which his Report refers. We have given below a portion of that of Messrs. Robert Dymond and Sons, to Lord Palmerston, respecting the system of pipe draingae at St. Thomas, Exeter.

After detailing the system employed at St. Thomas's and the expenses incurred therein, Messrs. Dymond state, that the works of the Local Board include the construction of tanks to receive the sewage at the outfall. The cost of this portion of the works, including the purchase of about one and a-half acre of land, a right of way, &c., was about 700*l.*, a sum which is not included in the above 1671*l.* 10*s.* 3*d.* These tanks have been let for a term to a chemical manure manufacturer, at a rent which, though moderate, produces a return to the Local Board of about 6 per cent. per annum on their expenditure upon this portion of their works, or about 1¾ per cent. on the total cost of the public sewers and receiving tanks.

All the private drains are formed of glazed stoneware pipes; those receiving the contents of single waterclosets are of 4 inches diameter, and those carrying off the flow into sinks are of 3 inches diameter.

All privies and cesspools have been abolished, and waterclosets have been substituted for them. As a very considerable amount of house drainage has been executed by parties employed directly by the owners of the property, and not by the Local Board of Health, it is difficult to ascertain the exact cost of private works, but the following statement is believed to be accurate:—

| | | | |
|---|---|---|---|
| Average cost of private drainage works, including erection of waterclosets, or conversion of privies into waterclosets, per house | £2 | 17 | 1 |
| Ditto ditto private water supply | 0 | 18 | 1 |
| | £3 | 15 | 2 |

Messrs. Dymond then come to the second part of the inquiry, viz., how the drainage has answered, and whether the pipes have worn out, given way, or been stopped up; and they proceed:—

"The drainage, both public and private, has fully answered its purpose; the public sewers have now been in use for two years, and although, from the level character of the district, the best inclination to be obtained from the 15 and 18 inch main sewer is only 1 in 1000 for a length of 3347 feet, it has proved fully adequate to carry off not only the ordinary rainfall and house drainage, but extraordinary storms. No stoppage has occurred in a public sewer, and the greatest amount of deposit in them has been about 1½ inch. This is removed by the natural flushing afforded by rainy weather. As a matter of precaution, it was deemed prudent to provide a simple means of flushing the most level portion of the main sewer, but there has hitherto been no necessity for its use. In the private drains there have been about a dozen stoppages since the new works have been in operation. The poorer classes were accustomed to dispose of refuse of various kinds by throwing it into open pits in their courts or gardens, which served the double purpose of dust-bin and cesspool. It was not surprising that new habits of order and decency were not in all cases formed as rapidly as the new waterclosets were completed; and hence half the number of stoppages were found to have been occasioned by pieces of flannel, rags, or straw carelessly passed into the drain pipe through the closet pan. These instances are becoming more and more rare as the people discover that the inconvenience and expense arising from such act of carelessness fall on the perpetrator alone. The other cases of stoppage arose from the washing of fine gravel and sand from the surface of courts and paths into the stoneware syphon traps attached to sinks. By a change in the form of the sinks, this difficulty has been obviated; we apprehend that both description of stoppage would have occurred, of whatever materials the drains had been constructed. No pipes have worn out, nor do any exhibit a tendency to do so. In short, a properly-made stoneware pipe may be regarded as imperishable—a quality which is not possessed by any other material employed in the construction of sewers; pipes have occasionally been broken by careless workmen before being laid in the ground, but none have given way afterwards. Although the larger-sized pipes were not formerly of the thickness which we have in our later works thought it desirable to provide; and although a large proportion of these pipes were laid at a depth of more than 10 feet below the surface, no accident or failure has occurred from external pressure, the weight of superincumbent soil, or any other cause. The nature of the ground in which the pipes for the main sewer were laid—a river gravel—rendered it necessary to exercise much care in filling-in the trenches, lest the pipes should be broken by falling stones. The clerk of the works had instructions to see every pipe inserted in its proper direction and level, its bed duly formed, and the filling-in at the sides and top cautiously and tightly rammed. Attention to these instructions has rendered St. Thomas's free from the accidents and failures which have elsewhere occurred from neglect of these precautions."

The result has most completely justified their opinion. Up to about 18 inches in diameter, Messrs. Dymond entertain no question as to the superiority of stoneware over every other material. Below this size it is more economical than bricks, but above it brick is cheaper, and perhaps preferable on other grounds. Stoneware pipes are in their opinion unquestionably the best for house drainage, and they are as fully satisfied of their superiority in public sewerage. The choice of them in other places in which they are engaged in superintending works of this nature is a practical evidence of this. The chief element of success appears to consist in strict and zealous attention to minor details in execution. If this be given, there is no reason to apprehend any damage or obstruction in the main system, and, in the event of their occurrence on private premises, they are readily set right. They have found no difficulty in providing, by very simple means, for the removal of noxious gases generated in the sewers, for flushing if desired, and for ascertaining the locality of any stoppages.

## ON THE DRAINAGE OF BUILDINGS AND STREETS IN THE METROPOLIS.

By W. A. Boulnois.

[*Paper read at the Royal Institute of British Architects, March 20.*]

In venturing to offer a paper on this subject to the Institute, I have not been influenced by a desire to communicate any special experience or information of my own, but simply by a wish to induce a discussion upon the controversy which, as we all know, has long existed, upon the methods and schemes of house drainage. The question lately received a great deal of attention at the Institution of Civil Engineers, and complaints have been loudly made by some of the disputants that their opinions did not receive sufficient notice in those digests or summaries of the proceedings in which the Institution is wont to condense the information derived from a debate. Here they will be able to express their opinions without reservation, none of our principal members being, as far as I am aware, pledged, as they contend the principal members of the other house were, to one side of the question; and they will be reported precisely in proportion to the clearness and accuracy of their remarks.

Every member of this Institute is, I am sure, anxious that the subject of drains should be well ventilated, however doubtful he may be as to the manner in which the drains themselves can best be so. It would really appear strange to any man unacquainted with the deep-rooted prejudices, aud the hot-headed partisanship of Englishmen, that a matter involving their most important interest, their health, their money, and their pride, should not ere this have been fixed upon such principles, that though there might remain a disappointed opposing few, the vast majority would have been entirely of one mind. When we consider the composition and character of the respective Boards of Metropolitan Commissioners of Sewers, since the public has been roused to the need of efficient servants in that capacity, the talent and ability of almost all their officers, we are fairly surprised that a controversy should be still raging as well on the things to be done as the manner of doing them. It is not too much to say that the ablest men of the kingdom have occupied themselves generally with the sewer question. It has been the disagreement of professional men upon details, which has alone prevented their labour from bearing fruit. And now that we are nearer to a settlement of the question, we find that the finances necessary to carry out the measure have not been considered or provided for, as it was not worth while to prepare the way for expenditure whilst the manner in which the money should be spent was undetermined. Surely it should be the earnest wish of all right-minded men, without prejudice against new-fangled notions, as they are termed, on the one hand, or an absurd retention of theories unsupported by practice on the other, to arrive at such a conclusion on this subject as shall obviate the evils complained of. This is not to be done by avoiding controversy within such walls as these, or in papers and pamphlets in which facts and opinions can be stated and refuted, but by abstaining from abuse of all parts of a given system of drainage, because one's own nostrum is not in it; by abstaining from false and overstrained statements of wasteful expenditure as it is termed, because our own nostrum is not experimented upon; and especially from a system of hand grenade penny-a-line warfare, which has been the destruction of all the respect usually felt by the public for bodies of scientific men who are desirous to serve it with honour.

It is a custom with architects now—I think much more honoured in the observance than in the breach—to begin all descriptions of practice with a reference to the ancient methods. I cannot do the justice to this part of the subject which it deserves, and which many here present could, but in confirmation of what was said the other night as to the antiquity of the claims which most modern inventors set up, I may refer to some portions of tubular drains brought from Ephesus and Miletus by my friend Mr. Falkener, which are now on the table. I learn from him that there is ocular demonstration of the use of similar drains at Pompeii; in one case the hollow in which the pan was bedded in the wall clearly indicates its shape; it was on the first floor, and from the curious arrangement of the syphons, which are described as existing in the ornamental arches of the City, we may fairly conclude that the Pompeians had WATER closets. As the drains were laid under the ornamental pavements through the principal portions of the house, and centered in the impluvium passing away in one channel through the prothyrum or passage, we may conclude that probably, from a greater fall, better workmanship, and the constant running of water which took place from the fountain in each house, they did not require to be so frequently laid open as ours do. No excavations have been made which show the size of the sewers in the streets in Pompeii, and it is greatly to be wished that some one competent would investigate this subject—permission would readily be granted for the purpose by the authorities at Naples to any one so well recommended, as an advocate of the pipe system would now probably be, by the Secretary of State for the House Department.

At Pompeii there are indications that the same construction of the street water-courses under the pavement or trottoir, which exists now in the Corso, at Rome, was practised. I have endeavoured to explain this by the drawing on the wall: the water-course is entirely under the pavement, which is of travertine, hollowed to form a series of long arches over it. There are some advantages connected with this method which might warrant its adoption in our streets; a much greater fall could be given to the water-course so as to obviate those elongated puddles, which after heavy rains are not uncommon near the gulley heads in our streets; the kerbs would not be so much worn as they are at present from the custom of using them as trams by weighty carts, and the horses would be relieved from the strains necessary to remove heavily laden vehicles from them. I have been informed that this is the most fruitful cause of jibbing in horses, and that in some parts of London it is a serious injury to the omnibus proprietors.

The pipe drainage advocates having antiquity on their side as regards house drains, it is satisfactory, on the score of an even debate, to find for the large sewer advocates, the CLOACA MAXIMA at Rome. We are, however, indebted for more than would first appear of our present system to the Romans. Our system of sewers originated in the covering in of open watercourses, and at the Fleet-ditch and the Wallbrook sewers, old Roman brickwork is intermingled with modern work, or was until quite recently. The present adaptation of the sewers has been the growth of a long and very costly rule-of-thumb system. All the men who have since Wren's time been consulted about sewers, and they are not few, were probably unable to apply, even if they were acquainted with, the principles of hydrodynamics. They were employed on piecemeal improvements, and it is fortunate for us that the earliest of them did their work so well as to set tolerable examples before the ignorant parish authorities and inefficient surveyors, who, until comparatively modern times, have managed the drainage of London. It is a subject of great congratulation, as it seems to me, that of the 1000 miles of sewers constructed under the Commissioners, and the 50 miles of City sewers, there should be such a large proportion which is useful, when we consider its progressive development, the divided interests which have worked it out, and the uncertain and hap-hazard way in which the extensions to this great town have been made. It is quite certain, moreover, that we have derived all our present knowledge of the subject from the imperfections of the previous works, so that we have in that way largely benefited by the mistakes of our forefathers.

The division of the subject of the removal of refuse from the buildings and streets of the metropolis, which is most simple, and admits of the readest discussion, is into DRAINAGE, SEWERAGE, and OUTFALL. DRAINAGE has to be considered under the head of *subsoil drainage*, *surface drainage*, and *house drainage*. The necessity of subsoil drainage in a locality entirely sublaid by an impermeable stratum, such as the London clay, needs no argument; and though it has been, and is ignored by many sanitary reformers, it is in fact almost as important as the house drainage. Damp soils and damp basements to houses are as constant and as deadly destroyers of human life as all the foul emanations of undrained refuse. The economy of effecting this subsoil drainage by the same sewer which is to convey the house drainage admits of no question, as it seems to me; and it is very efficiently provided for by the construction now adopted in the sewers of the Metropolitan Commission, which are built in cement to the height of the internal flow, and in mortar over this, which admits of the percolation of the water in the soil above and around them. The City has long been pre-eminent in respect of its subsoil drainage over almost all towns in the world.

One of the places most insisted upon as an experimental proof of the efficacy of the pipe drainage is Tottenham. Now there is a portion of Tottenham, lately called Marsh-lane, but now Northumberland Park, where the system of the Board of Health has been most efficiently carried out by Mr. Pilbrow; the houses are well drained, but the subsoil drainage not being provided for, the basements after heavy rains stand in water; the year before last the water rose in the basements of some which I had occasion to visit, 18 inches, and had so saturated the walls as to injure them permanently. Had the drainage been according to the system of the Metropolitan Commissioners of Sewers, this most serious evil would have been avoided, and the house drainage equally good. I am aware that a sufficient fall could only have been obtained at a great distance. and that the present system is the only one the place could yet pay for; but it affords a strong proof of the great gain which, when there is opportunity, arises from the combining the subsoil and house drainage.

The surface drainage, by which is meant the removal of the rain-water, is that branch of the subject which opens up the question of small or large sewers. The rain-water which falls on a given area, would seem to be specially intended for the cleansing of the refuse which may be on the surface, and very good reasons should be given why this is objectionable as applied through the sewers before we depart from so natural and obvious a use of them. The chief reason given by those who seek to separate surface and house drainage is an economical one, the cost of the sewers they say may be reduced to such an extent that you can have two systems, one for house and the other for surface drains, at a less expenditure than you can construct your sewer large enough for both. Now granting for a moment that the systems of small sewers will do for *house drainage*, as perhaps it will in some special and favourable cases, it is unquestionable that sewers large enough for the passage of a man to clean them would be required for the rain-water or surface drainage in this metropolis; the detritus from macadamised roads forms a concrete much more difficult to remove than all obstructions in sullage, and no gulleys (of which one of the best forms as found in the experience of the Metropolitan Commissioners is exhibited on the wall,) are able to prevent this deposit from accumulating in our sewers.

We in this Metropolis, with our levels, if we desire to be able to cross our streets without boats, and occupy the basements of our houses for more than two hundred and fifty out of the three hundred and sixty-five days in the year, must have sewers for the rain-water, not of the theoretical size requisite to carry off a given rainfall, but of size sufficient to admit of these sewers being approached for cleaning. The economical reasoning therefore fails.

The theory so carefully elaborated in some of the treatises on drainage, of forming surface drains literally at the surface, and only covered by the requisite thickness of stone or other material to protect them from the carriage traffic, and admit of their being easily cleansed of the road-dirt, forgets that the front areas and rear portions of London houses, the gardens, and the basement areas are usually 12 or 14 feet below the street level, and totally neglects them.

Having then the necessity for large sewers for the *surface drainage*, and of deep sewers for the *subsoil drainage*, we are next to inquire into their applicability to *house drainage*, or the substitution of other methods. Great improvements have within the last half century taken place in the *house drainage* of the Metropolis independent of the question of the size of the drains. Cesspools are, I believe, no longer contended for. Water-closets are considered essentials by a class of people, whose fathers would have as soon expected to ride in their own coaches as use them; and that periodical and dreadful infliction upon Mr. Paterfamilias of "something wrong with the drains" is, within the houses at any rate, less frequent than formerly. This last effect is doubtless attributable to the general use of the tubular pottery drain; not that all the improvements have been made with it, but because the builders and bricklayers who would not use it, were compelled in support of their prejudice in favour of the old barrel drain, and for the honour of the cause, to build their brick drains somewhat more smoothly than they had been in the habit of doing. The main cause of improvement, however, is the information which was given to practical men by scientific men upon the necessity of an uniform inclination in place of the flat incline and sudden fall near the sewer, which was commonly adopted in house drains, and the knowledge which has reached even housemaids and footmen, that a good scour of water through the drains is better obtained by a plug under the lifted water-closet handle during the coming in of the water supply than by the old and time-honoured expedient of pouring pailful by pailful down the grating in the back area.

Greatly indebted we are to the sanitary reformers on this subject, and we may offer ourselves the same congratulations upon their experience as we do on the practices of our fathers; we know now what to avoid. Their 2-inch pipes from sinks, 3-inch house drains, and 4-inch combined drains, are now as much things of the past amongst practical men as a cesspool under the centre of the front kitchens; 4-inch pipes from sinks, and 6-inch from water-closets, are the smallest which practice has warranted us in adopting. Theory proves, and proves satisfactorily, that a 3-inch pipe with the inclination ordinarily obtainable in London, would be enough to carry off the refuse from a first-class house, but practice has discovered such frequent stoppages even of 4-inch pipes, that they are now scarcely ever used.

I could give the history of numerous and various individual failures which have arisen, but others will occur to all the members. We are sometimes told that these are *preventible stoppages*, and that the small drain gives increased cleansing power to the water in the contents, and is so much better as to warrant the adoption of the means to prevent the insertion of improper substances at greater cost than we are now accustomed to do: in other words, that the trap should be improved and altered. How often would even the 3-inch drain be quite full of water so as to push the substance in suspense before it? This great and inherent evil of *stoppages* is sometimes met by saying that you must teach the people not to put matters down the drain which will cause stoppage, and that a population must be thoroughly imbued with the belief that the omission and commission of sins against the drains will cause a recoil upon themselves in disease and death; but we must change the character of the human mind before this desirable period will arrive; do not men commit sins of omission and commission upon the ducts and sewers in their own bodies, knowing that they will recoil in the shape of disease and death?

The most fruitful causes of the failure of pipes have been the joints; butt joints are specially liable to this observation; when laid in ground which is not very solid and consistent, the lengths are liable to shift, and an irregularity causes a lodgment of a small portion of the matters floating down; once begun, the evil speedily accumulates, the obstruction gathers from each passing substance which is not of sufficient tenacity to resist it, and eventually entirely chokes the pipe.

With reference to whole socket pipes, practical men are divided in their opinion as to whether they are best set in clay or cement; for my own part I think it essential to pipe drainage that no extraneous matter should possibly get into the pipe from the outside, and I think they are best set in cement. All house drains are best waterproof; a stoppage may, if this is not the case, exist for a long time in a drain without detection, as the fluid sewage oozes through the joints and saturates the surrounding ground. In a gravelly or sandy soil this evil may have been proceeding for months without notice. Half-socket pipes I think are the best, as they offer the opportunity of removal without breaking them upon the occurrence of stoppages; and it is more easy to determine when they are accurately laid, the upper semicircles of the two pipes abutting against one another affording a good test of this. The thicknesses of the pipes have, with sound judgment, as it seems to me, been increased by the resolution of the Metropolitan Commissioners of Sewers; they must now be ½-inch for 4 inches, ¾-inch for 6 inches, 1-inch for 9 inches, and 1¼-inch for 12 inches. Beyond this, the Commissioners do not permit pipe drains within their jurisdiction, as they have been found to break and cause great damage and expense.

The glazing of the tubes inside, though very desirable and of indirect utility in causing a better pipe to be burnt than would otherwise be, is not of any material assistance to the flow of the sewage matter through them. There forms in all sewers a sort of slime against the sides and bottom, which is after a very short period as efficacious in giving a smoothness of bore as the most expensive glaze would be. Too much attention cannot be paid to the bedding of the tubes at a true inclination, a very small error in the levels being of much more importance than in a large drain, where there is opportunity for adjustment of an even inclination in the current; it is obvious that 3 inches wrong with a 6-inch tube on a very flat incline, will be equivalent to the stopping up of half the tube.

With reference to the question of using *back combined drainage*, or *a separate drain* from each house to the sewer in the street, there are many considerations which are not usually taken into account by those who advocate the first of these systems. We have seen that street sewers are necessary on account of the necessity for *surface drains*, and that they must be so large for this special purpose as to admit of their being applied also to receive the *house drainage* (I do not apprehend that the most earnest advocate of back drainage ever proposed that the surface drainage of the street should be at the rear of the houses). We have then to consider whether it is better that the block of houses should be drained at the rear in the back courts or gardens by a combined drain which is turned into this sewer at one point, or that each house in the block should have its separate opening into this sewer. I pass by the considerations of invasion of private property involved in the combined back system, and the more serious danger of intentional stoppage and cutting off the drains, of which perhaps nearly all of us here have seen instances, as they are by no means uncommon. I pass by the necessity which in almost all cases there would be, that the combined drainage of the whole block should flow under the end return house, and the much greater liability there would be that a stoppage should occur in the small drain, say 12 inches diameter, than in the sewer in the front, and that all the inmates of houses in the block would be the sufferers for the neglect of one. I pass by these considerations, though they are enough to prevent the adoption of back drainage without strong local reasons in its favour, and I come to the main point at issue between the advocates of one system and the other, viz. the economy. Now, first we must have a drain from the front area in all streets, so that we have the length of the drain from the front area to the water-closets and sink in the basement and the back area, if there is one, to set against the length of the drain from the water-closet and sink to the back combined drain, and the frontage of this combined drain along the house. Almost invariably with modern houses in blocks, there are rear projections, which are quite as wide as the front area, generally they are wider, we have therefore to set the extra length of the pipe in the house (on the supposition that the sink and water-closets are at the rear as they usually are) against the frontage, and we have in this to set 12-inch pipe frontage, and one 12-inch T piece, diminishing to 6 inches against a straight 6-inch pipe through the house. It is clear that in nineteen cases out of twenty, back combined drainage would be more expensive than separate front drainage, provided they were both equally well done. It suits well perhaps with the views of speculative builders in outlying parts of the town, where there are no basements to the houses, and surface drainage is not yet provided for—the parishes not having had the roads and pathways handed over to them—to obtain permission to insert all along the rear of their blocks, before the garden or back court fence walls are up, a cheap 15-inch drain instead of an efficient sewer in the street; but it is of immense importance that their views should not be complied with to the prejudice of the health of the inhabitants of their houses, and the property of the persons who purchase their interest in the houses when they have let them.

Were each man who builds in this country his own freeholder, there would be no question as to the combined back drainage—it would not be tolerated; and because we have a vicious system of leaseholds which enables such propositions to be entertained and to be hailed by some of the small builders, are we to be told that the Commissioners of Metropolitan Sewers, who have wisely permitted the system only under such local circumstances as make it obviously desirable, are neglecting the objects of their apppointment and stifling the truth?

We now come to the second division of the subject—SEWERAGE, by which is meant the arterial drainage from the house drains to the outfall.

We have arrived, in considering subsoil and surface drainage, at the fact, that a sewer larger than the theoretical size is necessary, and after making due allowance on that account, we can with tolerable accuracy determine what should be the sizes of the sewers. As they gradually approach their outfalls they receive increased amounts of drainage from the increased area they traverse; the average of the make of sewage over a given area of inhabited houses in London has been tolerably accurately obtained by experiment.

It is found that in six hours in each day, as much sewage comes down as during the remaining eighteen hours; the rainfall is taken by the engineers to the Metropolitan and City Commissioners at 2½ inches over the entire area, after making proper deductions for the effect of evaporation and absorption in dry ground, and upon the formula of the square root of the hydraulic mean depth, multiplied by twice the fall in feet per mile, minus one-tenth for friction, equalling the velocity in feet per second, the capacity of the sewer can be calculated. It is a fact seldom admitted by pipe sewer advocates, but nevertheless true, that many of the old London sewers are too small, as well as many too large, upon this principle.

It is sometimes forgotten in the controversy on the part of the pipe advocates, that upon true hydraulic principles, the sizes of the sewers as calculated for their drainage capability only, soon reach such dimensions as that pipes are no longer available, even if they answered their ends. Besides, were they laid with reference only to the immediate requirement in places where they would be sufficiently large for it, they do not admit of extension to embrace the drainage of an increased number of houses, a point very necessary to be considered on all grounds.

Pipe sewerage may be said to have been well tried in the Metropolis, and to have failed. On the wall are instances, by no means the worst, of the condition of pipe sewers, as ascertained by Mr. Bazalgette, the engineer to the Metropolitan Commissioners, by their order. Many of these it appears were habitually flushed, and the investigations were made by the officer to the Commission, solely with a view to ascertain the applicability of pipe sewers in the future operations of the Commission. The present shape adopted by the Commission answers, as far as its bottom goes, all the ends of a circular sewer in diminished friction, and as the perimeter widens, it must (by the well-known principle of hydraulics that the resistance of every particle of the fluid is in direct ratio to the perimeter of the section, and inversely as the area of its section) give beyond the semicircle a greater velocity in feet per second.

The sewers now built under both Commissions are constructed upon sound hydraulic principles, and we may hope that there is no waste of public money for want of an ample scientific knowledge, both of the requirements and the best method of answering them.

There are details connected with the sewerage which it is worth while to allude to, as many differences of opinion exist upon them: the ventilation of the sewers is one of these. It is admitted on all hands, I believe, that till we have a perfect water supply, and our sewers are scoured as those of Paris now are, by strong streams of water, provision must be made for the occasional passage of labourers in them to cleanse them. And even when this much-to-be-longed-for time arrives, entrance will be necessary for the repairs, which will be rendered more frequently requisite by the scouring. If the sewers are to have labourers in them they must be ventilated, and it is a question which is the best method of effecting this; many schemes have been proposed.

A direct air shaft leading to the centre of the street is adopted by the Metropolitan and City Commissioners, though they admit that it is open to great objection. A plan which has been used with success in many places, is to connect the rain-water stack pipes with the sewer. Mr. Varley, the water-colour painter, read a paper at this Institute, in 1846, descriptive of this method; his diagram is on the wall. Shafts and furnaces for draft have been proposed, but would entail enormous cost. It has been proposed to compel all persons having steam boilers for manufacturing purposes, as brewers, mechanical engineers, and the like, to admit the foul air from sewers to their chimney shafts; but it is doubtful whether this would answer. The chimney shafts would hardly always be in the highest levels and very long adits would have in most cases to be run to the nearest sewer. Dr. Buckland came down here one day to propose that the gas lamps, in certain requisite numbers, should be connected with the sewers by shafts, and that iron cylinders should convey the foul air outside the stalk of the lamp to the flame, which would consume it, or destroy its noxious qualities.

Some have proposed, that every house to be built or rebuilt, should be compelled to have a flue in the party wall for the use of the Commissioners of Sewers, should they need it, to ventilate the sewer at that part; this does not seem an impracticable plan, and perhaps it will be considered in the New Building Act, which, we have been informed, is now in the hands of the Board of Health. At any rate, ventilation in the sewers must be provided.

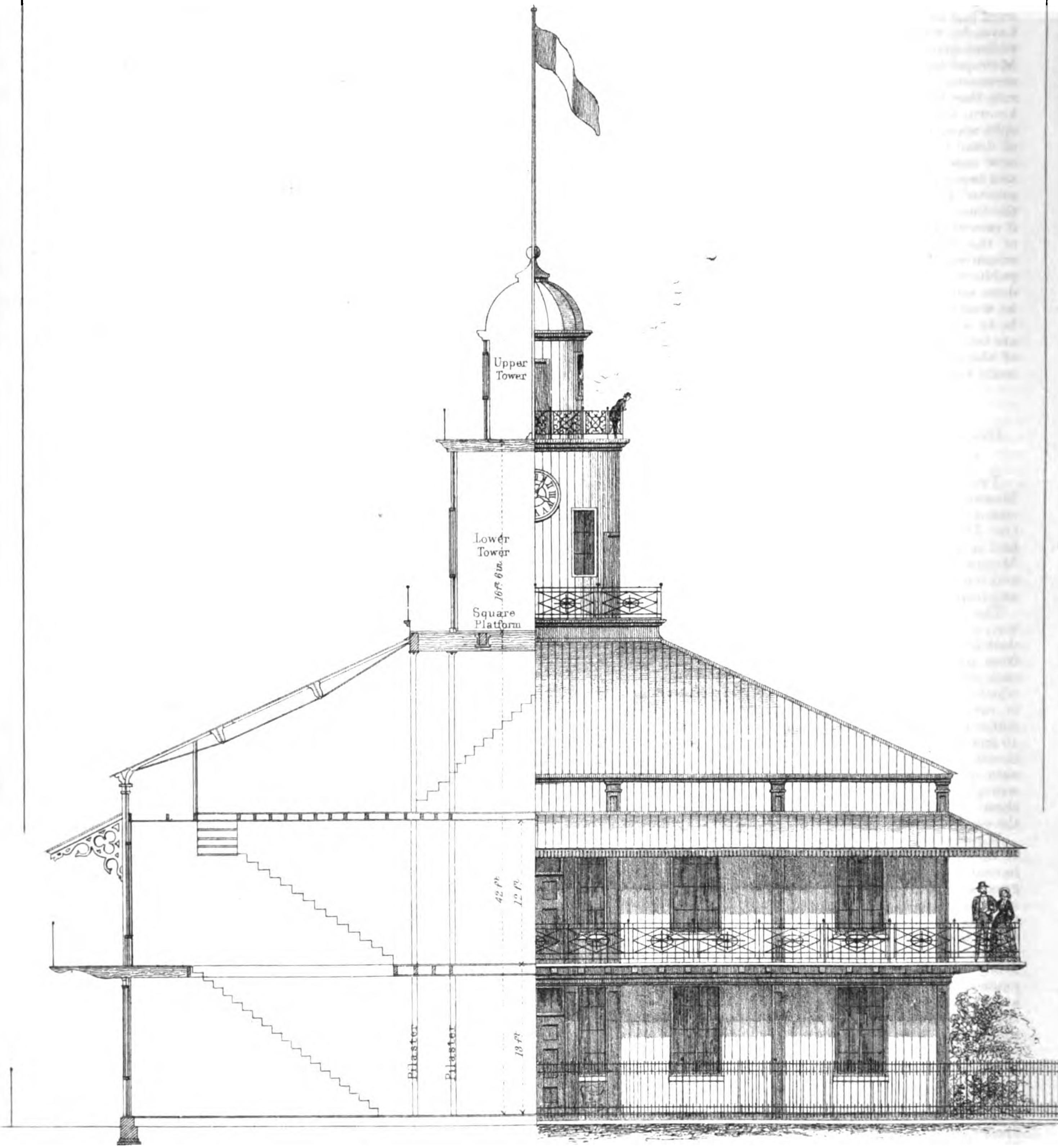
Flushing is a point to be noticed in the consideration of sewers. Great improvement has been made in this method of cleansing the sewers, and with a perfect water supply, there is no reason why it should not be extended to such a degree, as to almost entirely obviate other methods, except in flat situations, where raking will probably always be requisite.

A system of flushing has been proposed by Mr. Jennings (whose clever contrivances in connection with drainage details, entitle him to the thanks of all architects and sanitary reformers, and some of whose inventions surround us), in which the accumulated refuse of each day is released at a given moment from a receptacle constructed under each house, any number, say 100, such receptacles being opened at once by the aid of wires and cranks, or electricity, it is supposed a rush would take place down the sewers which would clear everything away with it. Another invention by Mr. Salter, to which my attention has been brought by Mr. Jennings, is the self-acting flushing gate, in which by an outflow pipe from the upper level, communicating with a tilted box on the lower level, or in the side entrance, the sewer itself, when full, forces up a catch lever and releases the gate. It is very ingenious, and is recommended from experience by the authorities at Leeds.

Time will not permit me to treat of the many other matters connected with the sewers, which will, I hope, come out in discussion, but we must pass to the OUTFALL, on which I can say but very little, except that having read digests of all the schemes

# IRON CUSTOM HOUSE, PAYTA, PERU.

Mess.rs Edw.d T. Bellhouse & C.o Eagle Foundry, Manchester




HALF SECTION

HALF ELEVATION.

Scale.

0 5 10 20 30 40 50 60 Feet

J.R. Jobbins

submitted in competition to the Commissioners of Sewers, I do not believe there is one except that of Mr. McLean, for intercepting the higher levels, and taking the lower under the Thames at Vauxhall, which is practicable, without such an enormous outlay of money as to quite preclude it from consideration.

Were Lord Palmerston for one week at the Sewers' Office, or even had he to make application there so frequently as we all have, he would have long considered before he took such a violent course as to declare the whole of the proceedings of the Metropolitan Commissioners, since they had been in office, erroneous. Lord Palmerston would have known, that at any rate they had endeavoured to get at the truth; he would have known, that seeing the rock the two previous Commissions had split upon, viz., chimerical scheming in the one case, and a neglect of detail for a grand measure in the other, Commissioners were now only anxious to do their work so that it should be lasting and beneficial. He would have known, that their officers were selected with the utmost care, and that no crotchets now took up the time of these officers; no endeavours to make out cases, which, if proved, could not be carried out without an entire remodelling of the whole Metropolis; no rival schemes within the very executive office of the Commission taking up the time which the public was paying for; and before he took a step likely always to deter sound men from engaging in the public service voluntarily, he would have waited till he was better informed than he could be by a letter containing heads of a controversy, most of which are long since settled in practical men's minds, and every one of which, had he asked information of the Commissioners, they could have given him sound opinions upon.

## IRON CUSTOM-HOUSE AND STORE, FOR PERU.

(*With Engravings, Plate* XX.)

Two large buildings of iron have recently been prepared by Messrs. E. T. Bellhouse and Co., of Manchester, intended for a custom-house and general store for the town of Payta, in Peru. Our Engravings represent these buildings half in elevation, and half in section. These structures have been erected complete in Messrs. Bellhouse's yard, and attracted considerable attention and interest, which was shown by the fact of their being visited and inspected by 25,000 persons in ten days.

The Iron Custom-House consists of a square block, 70 feet each way, of two lofty stories, surrounded by a balcony at the second-floor level, and an ornamental verandah, each projecting 2 yards from the face of the building. The roof inclines upwards from each side, meeting at a square platform 23 feet across, and above which rises a circular tower, 17 feet high, 15 feet diameter, which is surmounted by an upper circular tower and flagstaff. The edifice is inclosed by iron railings and gates, leaving a space of 10 feet on all sides; and the balcony and the platforms are inclosed by ornamental cast-iron railings. The external shell consists of strong cast-iron upright pilasters, and cross-pieces of wrought angle-iron, to which are bolted the galvanised corrugated sheets No. 16 wire gage. In this building, the corrugations of the sheets run in a vertical direction.

We need not here enter into a close description of the details of the building, as a brief account of the construction will suffice in connection with the section and details contained in our engravings. The pilasters are placed, at intervals of about 14 feet, upon base stones, from which they rise to the eave level, where they are connected by a cast-iron moulded eave-plate. From the top of the pilasters spring the trussed rafters of the roof, which incline upwards until they reach the square platform, and are firmly bolted thereto. This square platform consists of a strongly jointed framework of carpentry, covered with 3-inch plank and leaded, supported by columns which spring from stone bases at the ground line. The columns are so placed as to be covered by the partitions, thus being no obstruction to the passages or the rooms. We have previously mentioned the two upper towers, which are of iron; in the lower one is a clock having a four-feet dial.

The floor of the lower story is of 2-inch planks, grooved and tongued with iron at the joints. These planks are fastened down upon cast-iron bearers, which are supported by sleeper walls. The upper floor consists of timber joists, with the floor boards nailed on to the upper edges, and the ceiling boards below. In each story the interior is divided into a main central passage or hall 13 feet wide, with rooms and passages on each side. Stairs lead to the upper story, to the platform, and to the base of the upper tower.

The whole of the sides and ceilings of the various rooms and passages are lined with boarding, upon which Croggon's patent inodorous felt is nailed, which will be papered with a common lining-paper, and finished with coloured paperhangings. Windows, opening in the manner of French casements, afford light to the rooms. The bold projection of the balconies and verandahs, and the attention which has been paid to the details of design in the various pilasters, cornices, and mouldings, under the direction of Mr. E. Salamons, architect, have been productive of a good general effect in this edifice.

The Iron Warehouse or Store occupies a ground space of 120 feet by 90 feet. The walls are composed of strong iron pilasters (Bellhouse's patent), and galvanised corrugated sheets, the corrugations running in a horizontal direction between the pilasters. The entire building is covered by a roof rising to a peak in the centre, the framework of which is composed of trussed principals and bars of wrought-iron, covered with corrugated sheets.

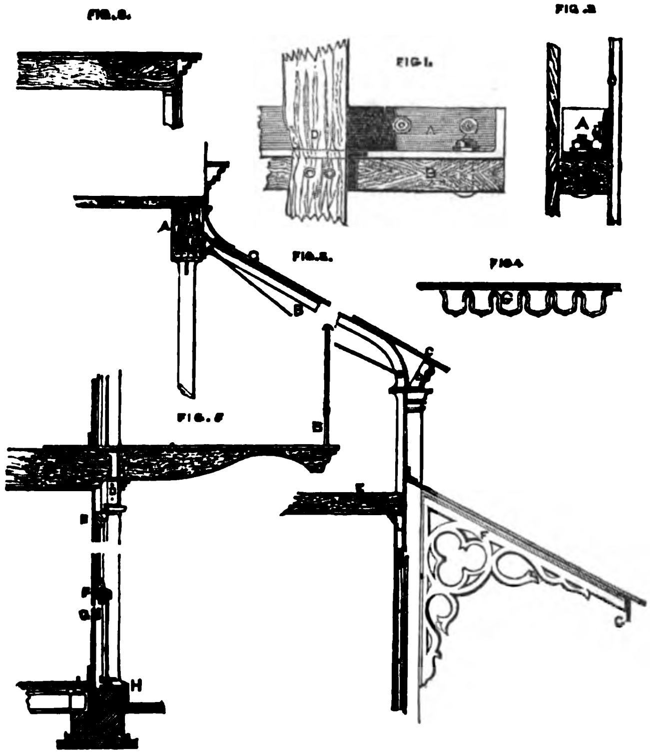


Fig. 1, of the annexed wood engravings, represents a side view, and fig. 2 a cross section, of the cross-bar of angle-iron A, and timber batten B, to which are attached the galvanised corrugated iron sheets on the outside, and the lining-boards D on the inside. In fig. 2, A, represents the wooden beam forming the curb of the square platform; B, the trussed principals of the roof; C, the corrugated iron sheets in the same; D, the cast-iron moulded cornice running under the eaves; E, the ceiling joist; F, the verandah, covered with corrugated iron sheets; G, the pendant, shown in elevation in fig. 4. In fig. 5, A, is the balcony; B, the railing; C, the floor joist; D, cast-iron beam carrying floor joists; E, the window top; F, window sill; G, cross rail; H, cast-iron base; I, the basement floor. Fig. 6, represents cornice and ceiling of the first circular tower, on the top of which rises the upper circular tower.

A covered inclosure, 60 feet by 30 feet, into which carts can be taken, is entered by a main arched grated opening, with gates, 32 feet high to crown of the arch, and 30 feet wide; the interior of the warehouse is entered from this inclosure. Light is admitted to the interior by means of windows at the sides and ends, in which are placed sliding casements for the admission of air for ventilation. Iron gratings are fixed on the exterior, and iron shutters on the inside of these windows.

The execution of these large iron buildings has been intrusted by Messrs. A. Gibbs and Sons, of London, to Messrs. E. T. Bellhouse and Co., and they have been constructed under the superintendence and direction of Mr. E. Woods, C.E., of London.

## ON WATER METERS.*

By J. Glynn, F.R.S.

[*Paper read at the Society of Arts, London, April 19th.*]

The inhabitants of large and populous cities require an ample supply of water, as one of the first necessaries of life; and as the people's wealth and civilisation advance, so does the demand for water increase.

If proof of this were needed, it would only be requisite to point to the splendid remains of the aqueducts and waterworks of ancient times; for the rulers of all nations and ages, except our own, seem to have thought it their duty to provide water in abundance for the health and comfort of their subjects.

In this kingdom, however, and more especially in this great metropolis, the case has been otherwise, and the supply of water has been left to become a commercial speculation and a means of employing private capital.

The consequence of this has been a limited supply, delivered at intervals, and received in cisterns considered large enough to contain as much water as the family of the house required for a day or two days' use; and this state of things continued until the public became so much dissatisfied, that the government has, to a certain extent, taken the matter into its own hands, and exercised the right of the strong against the water companies.

The people require a supply of water, when they want it, and as they want it; the wealthy inhabitants do not wish to be stinted; they demand a constant supply, continuous and unlimited, except by their own pleasure, and to pay for what they have by measure. But they do not want the cisterns: they are cumbrous; they are inconvenient; they get foul. They wish to open their water-tap whenever they like, and to have the water measured as they use it—like the gas—say at so much per thousand gallons.

In consequence of this demand, many ingenious persons have turned their attention to the matter, and exercised their wits upon it, so that not less than forty patents have been taken for inventions for measuring water and other effluent liquids and fluids—some of these machines being applicable to gas as well as water.

These patents bear date from 1824 down to the present time, and the Society of Arts, being sensible how very desirable it is to have a really good water-meter, has twice offered rewards for the best machine of the kind.

The essentials of a good water-meter appear to be the following:—1, that it should correctly measure and show the quantity of water delivered under various heads or pressures; 2, that it should not be liable to get out of order; 3, that it should be easily cleaned, oiled, or adjusted; 4, that the cost be not great, so that it may be generally used by householders. The majority of the water-meters hitherto invented have been deficient in one or more of these essentials.

In the Jury Report of the Great Exhibition, it appears that five of these contrivances were exhibited, but none of them so far perfected as to satisfy the conditions of a good meter. The jury do not even make honourable mention of any one, although they state how very much such machines are wanted.

Among so many inventive minds, it may be expected that their ideas would take various shapes, but as very few ideas are original, so in the attempt to develope that of a water-meter, we find that some other machine or contrivance previously known has been taken as the starting point in most cases.

As the cistern of the London dwellinghouse already mentioned receives and measures the daily supply, and by means of the well-known contrivance called a ball-cock, closes the tap when the cistern is full, it was thought that by having *two* little cisterns with floats in them, connected with inlet and outlet valves, to be opened and shut alternately by the floats, the cisterns might be filled and emptied by turns. Their contents being known, and the ebb and flow of the water registered, a very simple and compact meter for water delivered in large quantities at a low pressure may thus be made.

The same idea of twin vessels, and a reciprocating action by means of a diaphragm or flexible partition, has been further elaborated, something like the gas-meter upon that principle.

The reciprocating motion of a piston in a cylinder like that of a steam-engine has also been proposed, the water making its entrance and exit by means of a slide-valve, and a tolerably good water-meter has been so made; but there is some friction of the piston, slide-valve, "*tumbling-bob*," and other mechanism, which requires some force of head or pressure to overcome. If the force or head of water be considerable, its action is violent, but with an equable and moderate pressure an efficient but not a cheap machine may be constructed on the cylinder and piston plan.

Other forms of the steam-engine have also been proposed for water-meters, such as the disc engine, which combines the rotary with the reciprocating action. The water-wheel on a large scale, revolving in a circular case, has been tried in various ways, and is a favourite scheme, but not a successful one.

The clepsydra, or water-clock, in which water was formerly used to measure time, has been tried to measure water. In this a hollow drum or wheel, divided into chambers, has them filled and discharged in succession, each chamber or division containing an ascertained quantity of water; the wheel halts until it is filled, and moves when it over-balances and empties itself. Machines on this principle, however ingenious they may be, must be irregular in their action, and not suited for varying heads.

After this, come drums of many shapes, some receiving the water at their centre, others at their circumference. Of those taking the water at their centre, some resemble a fan-blast, some are like Appold's pump, and one like Barker's mill, which has ingenious contrivances for obviating friction, for continual lubrication, for straining the water as it enters, and for preventing acceleration of the drum or *mill part*—so to speak—of the machine, for which Mr. Siemens has a patent. There is a machine which is well known to sailors, and which has now for many years been before the public—Massey's Patent Log—for measuring the distance run by a ship. It is shaped something like a screw-propeller, but rather more like a fish's tail, when it uses it as a propeller. Suppose this put into a pipe, it will register the *rate* at which the water flows past. This is another type, and there are modifications of it in portions of screws, drums with spiral vanes, and so forth. Mr. Siemens has a patent of this kind, in which two or three spirals, so to speak, revolve in opposite ways, to prevent acceleration.

There are other forms also, but from what has been said, an opinion may be formed of the difficulties which attend the production of a perfect water-meter at a moderate cost; yet, as in most waterworks now in course of construction a constant supply of water can be delivered at high service to the consumer, it is highly desirable that he should be able to avail himself of such advantages, by using what he pleases, and paying for it by the quantity consumed. It is to be hoped that some water-meter will be invented, or some of those before us will be so improved as to meet the demand, and satisfy this Society and the public.

Since my paper was written—indeed in the course of to-day, upon coming here to see the several models sent in to illustrate the subject—I found there was one meter not mentioned in my paper, the invention of Messrs. Hanson and Chadwick, of Salford, near Manchester. This invention differs altogether from the meters alluded to in my paper both in arrangement and action. It consists of two flat semicircular bags of vulcanised india-rubber, in which the water is in the first instance received, a wire-gauze or sieve being introduced between the supply-pipe and the two inlet-passages. At the other extremities of the bags there are openings which allow the water to pass into the meter. The water, on entering these bags, sets in motion three conical rollers attached to a centre-spindle, in connection with the counting-wheels and dial. These rollers are kept constantly revolving, each revolution registering exactly the contents of the bags. Each bag is kept constantly distended with the water it receives, and as one of the rollers is constantly in advance of the outlet-valve, whilst another is immediately behind it, the quantity discharged is kept up with great regularity. There is one of the machines on the table, and I have this afternoon seen one at work at the New River Waterworks, where it delivered a steady stream of water at various pressures, and registered the quantity so delivered with considerable accuracy, and I am told that the difference of the delivery at moderate and high pressures is only 5 per cent.

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* For this and the succeeding paper and woodcuts we are indebted to the courtesy of the Society of Arts, from whose 'Journal' they are extracted.

## DESCRIPTION OF TAYLOR'S WATER METER.

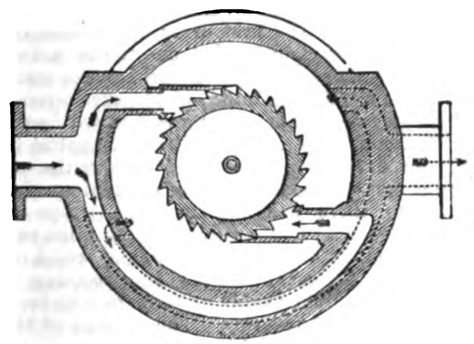
By Benjamin Fothergill.

[*Paper read at the Society of Arts, London, April 19th.*]

The invention of a meter more than thirty years ago for measuring gas, was considered to be the achievement of a most important object; they are now almost universally adopted, and there can be no doubt the result has been a public benefit. A machine for measuring water subsequently claimed the attention of men of mechanical genius, and a great number of patents have been taken out from time to time for water meters, but that which appeared plausible in theory, was found inefficient in practice. About two years ago the Corporation of Manchester advertised for a water meter; this was responded to by a large number of persons, and meters of all descriptions were sent to the Water Works Committee, for their inspection and approval. The meter in question was required to sustain the greatest pressure; the flow must not be interfered with by obstruction or friction, so as to hinder its ascent to the highest point of its source; it must measure correctly under every variety of pressure, and when subdued to the smallest amount of inlet, must indicate the quantity passing through the meter; and durability or non-liability to wear and tear must be an important feature, without which the machine would be of little value.

Mr. T. Taylor, of the Patent Saw Mills, Manchester, has had his attention directed to the subject for many years. He succeeded about twelve years ago in constructing one on the low-pressure principle, which was pronounced by Mr. William Fairbairn, to be perfect in its kind; in his testimonial he said "I have examined Mr. Taylor's Water Meter, and from a careful consideration of the principle upon which it is constructed, I am of opinion that it is one of the most efficient discoveries that has ever yet been made for measuring out and duly registering unapportioned quantities of water, &c." Other individuals also bore the like testimony. Mr. Taylor has invented five meters, all varying in their principle and action; four of these were considered to possess considerable merit, but failed to overcome all the difficulties previously noticed; the last, however, has been pronounced by competent judges to be perfectly satisfactory. This he patented December 15, 1852, and it has been before the Manchester Corporation. Since that time it has had the most severe tests, varying from the highest to the lowest pressure, and the result has been its approval by the Water Works Committee. There are now betwixt one and two hundred meters working in various parts of the country; they have been introduced into sixteen or eighteen towns, and have given universal satisfaction; there is one with a 12-inch bore pipe now working, and it is measuring the water supplied by the Corporation of Manchester to the township of Dukinfield, to the satisfaction of both parties concerned. The first meter made on this principle was fixed up at the extensive cotton-mills of Messrs. Birley, Manchester, where it has been working almost a year and a half, measuring from 35,000 to 36,000 gallons per day, and not the slightest disarrangement has occurred since it was fixed. Messrs. Birley have most confidently expressed their satisfaction in its principle and action.

Fig. 1.—Taylor's Water Meter.



The meter (fig. 1) consists of a cylindrical vessel or cistern, of a sized proportioned to the bore of the pipe that is to receive and discharge the water. Inside the above-mentioned vessel is a drum revolving on its axis in a vertical or upright position, and the stream passing through the meter is distributed upon the drum at each side of the meter. The registration is given by a train of wheels connected with the drum, and carried to the indicator, and by a combination of the under-mentioned mechanical arrangement forms the water meter patented by Mr. T. Taylor. The patentee claims for himself the under-mentioned peculiarities connected with his water meter:—

1st. The vertical position in which the drum is worked, the said drum being constructed of gutta-percha, thereby preventing liability to collapse or corrosion, the said drum being made to the specific gravity of water.

2nd. That the quantity of water contained in the meter be sufficient to cause the drum to be buoyant, by which arrangement the drum is made to revolve by the slightest action of the water against the blades or buckets of the said drum.

3rd. The arrangement or construction of thoroughfares or pipes outside the meter, communicating with the inside and round the drum for the delivery and exit of the water, and for causing a rotary motion in the water, thereby causing the drum, in addition to its buoyancy and vertical position, to be more certain of its liability to revolve under the slightest pressure of water. The construction of valves from the thoroughfares for the ingress of the water, which are so shaped that they bring the immediate action of the stream passing through the meter on the drum. The equal distribution and division of the stream (however small it may be), at each side of the drum, rendering its liability to wear and tear very slight, and whatever the pressure or power of the stream may be, by the above arrangement it is rendered neutral in causing more or less friction upon the axles or pivots of the drum, that being the same under any pressure and only sufficient to keep the drum in its position.

The above-mentioned valves are constructed after the plan of the common clack valve, which closes the apertures of the inlet, excepting a small tube fixed in the centre of the clack, and projecting so as to come into immediate contact with the buckets of the drum; the clacks are closed by a simple arrangement of a self-acting weight or lever above the valve, such weight being regulated by drawing it backward or forward on the lever (which being once regulated becomes a fixture and needs never be altered), so as to give more or less pressure on the clacks. The use or utility of these valves is occasioned by the fact that, although the drum may be neutral, yet there is necessarily a slight amount of friction to overcome in working the train of wheels to the indicator, which is done by the weight closing the clack and causing a compression of the stream, so that no water is allowed to pass but what forces through the clack tubes. This valve is only brought into requisition when a very small quantity of water is passing through the meter, and as the stream increases the leverage of the weight decreases, beyond which the valve is not required to insure correct measurement. If, however, on the contrary, the weight should not decrease in its power upon the valves when the stream becomes greater, and there was an increased pressure upon the clacks (as would be the case if a spring was in place of a weight), the result would be that the measurement would be incorrect, which has been discovered to be the case after repeated experiments with the spring in place of weights.

Its certainty of registration, its non-liability to wear and tear, and its certainty of working under the highest or lowest pressure, is caused by the buoyancy of the drum, its vertical position and the adaptation of the inlet pipes and compression valves to bring the stream, however small, into immediate contact with the drum and causing it to revolve.

The Waterworks Committee have ordered a variety of meters from Mr. Taylor, and, no doubt, as the merits of this invention become known to water companies, they will be generally adopted, and will be found to be a regulator of great economy, and will be estimated by the public as a protector of their just rights.

*Discussion.*—Mr. Chadwick wished, in making a few observations on the subject, to disclaim in the first instance being the inventor of the meter last brought under notice by Mr. Glynn, the design of it having been brought to him by a working plumber, George Hanson, of Huddersfield. He (Mr. Chadwick) was officially connected with the waterworks at Salford, and therefore it was that he had been led to take an interest in the subject, the Corporation being especially desirous that the quantity of water used should be correctly registered. They had tried various meters, but none of them had acted with the regularity and accuracy of that now upon the table (figs. 2 and 3), with which he had been experimenting for the last 18 months. Mr. Glynn had very correctly described the construction of the meter, which he believed had this advantage over all others, that, being air-tight, it would register any quantity of water used, however small, up to 1000 gallons per hour, which other meters would not do.

HANSON AND CHADWICK'S WATER METER.*

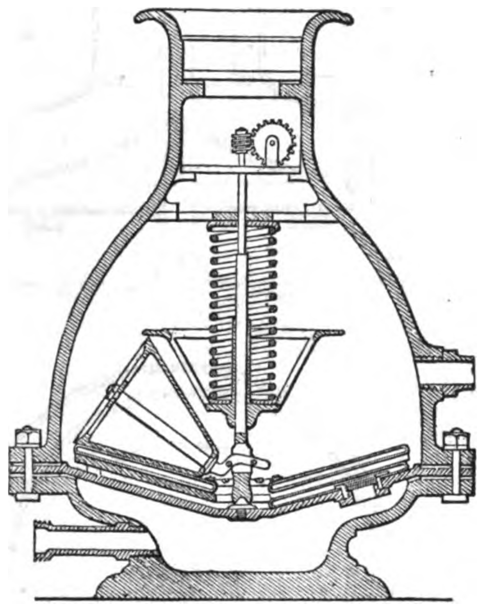


Fig. 2.

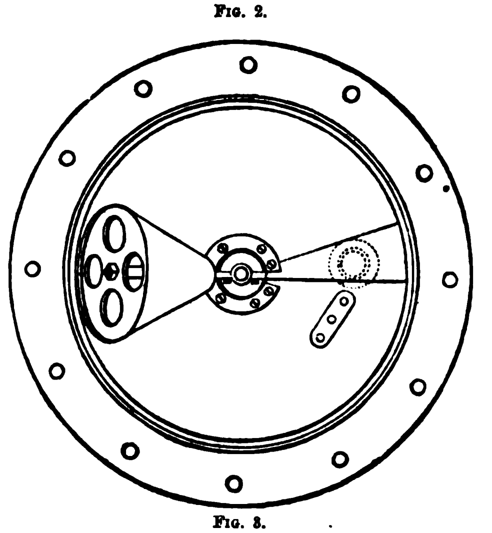


Fig. 3.

In saying this he did not wish to detract from the merits of Mr. Siemens' and Mr. Taylor's inventions, to which he was willing to give all praise. The first objection that would be raised by most persons to Hanson and Chadwick's meter would be as regarded the durability of the material used for the bags through which the water had to pass. He was assured by Mr. Mackintosh, the patentee of the vulcanised India-rubber, that however long it was exposed to the action of the water it would neither decay nor deteriorate; and as regarded wear and tear, from the form of the rollers there would be no friction upon the bags by which they could be injured. He had, therefore, no hesitation in saying that it would last in perfect order at least seven years—Mr. Mackintosh said twenty years. As to an objection that the bags might get unduly inflated, experience proved to him that that could never happen, as, when the rollers passed over the valves or openings in the bags, they never got an impetus in advance of the water; and a pressure of 200 feet had no greater influence upon them than a pressure of 3 feet, the rollers always going before the water. He might observe that he had not brought the meter under notice in his own neighbourhood, and, indeed, the first place in which it had been seen out of the workshop was at the works of the New River Company. He believed that this meter was a good contribution towards the production of a perfect water meter, and if it led to that result he should feel himself amply repaid for all the trouble and anxiety he had had with regard to it. He believed that no meter had yet been made so simple in construction; and having just been asked what would be the expense of it, he might observe that a one-inch meter, such as that on the table, would not cost more than 5*l.* or 6*l.* and a two-inch meter certainly not more than double that sum.

Lord Berriedale (the Chairman) could not allow Mr. Chadwick to depart without returning the thanks of the Society for his attendance there that evening. As regarded the durability of the material of which the bags were constructed, he could in some measure confirm the opinion of Mr. Mackintosh. He had had something to do with vulcanised india-rubber, having used it for springs in an invention which he had patented, and though he had had it at work for upwards of twelve months not one of the springs had broken, though they had been actually subjected to the action of oil instead of water.

Mr. Fothergill, in explanation of his paper, pointed out upon a plan the various portions of Mr. Taylor's meter, and stated that a valve had been so arranged as to regulate the stream of water, however small, so as to prevent too great diffusion, and thus cause it to impinge directly upon the drum. The meter would register 75,000 gallons an hour.

Mr. Siemens said he had, several years ago, directed his attention to the production of an efficient water meter, and Mr. Glynn having mentioned in the paper the result of his labour, he felt called upon to offer to the meeting a brief description of the contrivances he had adopted with considerable practical success. Fig. 4 was a sectional elevation, and fig. 5 a plan of one variety of his meter, and figs. 6 and 7 represented the working parts of another. Although very different in appearance, the two constructions, nevertheless, involved the same principle of action, namely,—the water acted by its impact upon oblique vanes that glided edgeways through the moving column, without interrupting or impeding the same, and that communicated their motion to a counter; the difference between the two being, that in the first arrangement the water moved in a direction parallel to the rotating axis, and, in the second, from the axis outwards. The water entered the meter, figs. 4 and 5 through a grating, and meeting the sides of the inverted cone (*b*), it was directed towards the axis, from whence it spread again outward over the conical block (*c*). The object of this operation was to spread the moving column of water uniformly over a measured annular area, after which there remained only to measure correctly the distance through which that column moved, and to register the same in expressions of gallons or other quantities upon a counter. For this purpose two drums (*d*) and (*f*), were provided, which were geared together, but were quite free to revolve in opposite directions, being made hollow, so as to float in the water, and all side strain upon the bearings being carefully avoided. The first drum was armed on its circumference with a set of right-handed, and the second with a set of left-handed screw vanes, of the same pitch, and of correct form, being cast of white metal in metallic moulds, specimens of which were placed on the table. The water was directed by stationary vanes upon the block (*c*), in a parallel direction against the vanes of the first screw drum, which it would turn in the exact ratio of its onward course, provided there was no friction. In proportion, however, as there was resistance the water would be deflected from its course, and would meet the vanes of the left-handed screw drum in a more obtuse angle, which tended to drive the same at an increased velocity, and, reacting upon the first drum, produced a remarkably uniform rate under the most variable circumstances of pressure. The motion of the drums was communicated to the upright spindle working in the chamber (*g*), where the motion was reduced several thousand times by screw gearing, after which it passed into the upper or counter chamber, through a stuffing-box. The counter consisted of two wheels of 100 and 101 teeth respectively, both gearing into the

* These woodcuts were made from the drawings attached to the specification. Since the patent was taken out, several alterations have been made in the details; the spiral spring has been dispensed with; the bottom of the cylindrical vessel has been made flat instead of inclined; three rollers are used in place of one; and a wire gauze or sieve has been introduced between the supply-pipe and the inlet-passages.

*Siemens' Patent Balance Meter,*

WITH HELICAL BLADES, TO WORK UNDER PRESSURE.

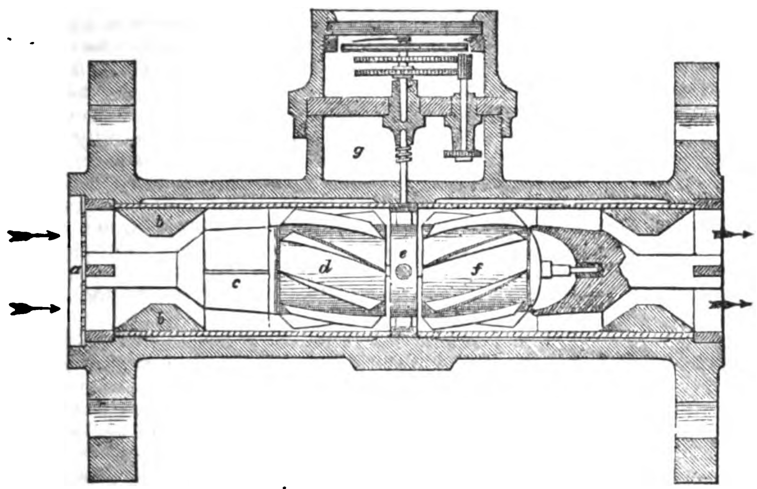



FIG. 4.

WITH SPIRAL BLADES TO WORK UNDER PRESSURE.

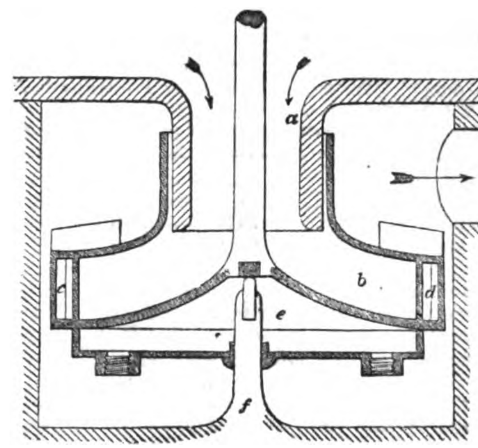



FIG. 6.

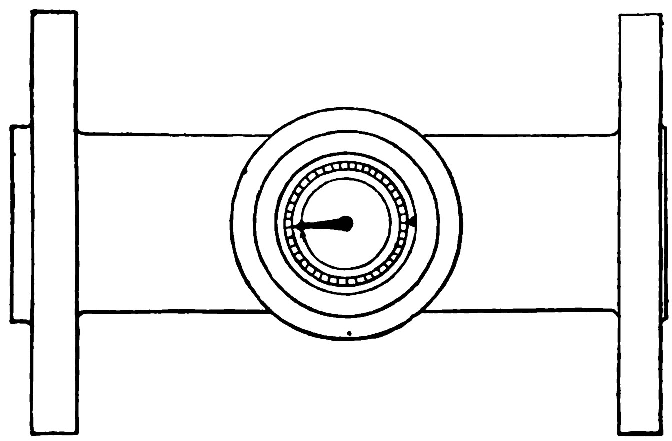


FIG. 5.

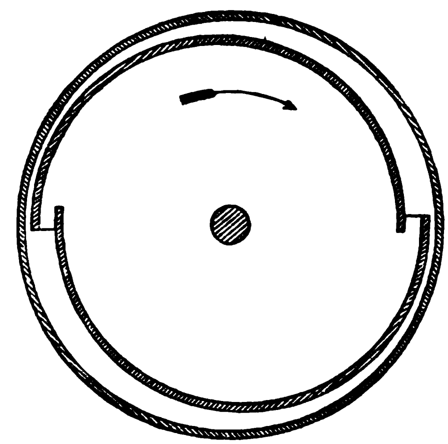


FIG. 7.

driving pinion—the one carrying a dial with 100 divisions, and revolving under a fixed pointer; and the other carrying a hand upon the dial. A reduction of from one to ten thousand was thus obtained, and registered by the two hands. Of these meters a great number had been used, and were found to work very correctly for from six to fifteen months, after which time, however, the spindles were frequently found to be destroyed by the corrosive and gritty nature of the water generally supplied to towns. It was, however, necessary that a meter should work for years without requiring the attention generally bestowed upon mechanism, although placed under the influence of many destructive agencies. These considerations determined him in favour of the construction with spiral vanes, as represented in elevation by fig. 6, and in plan by fig. 7, without the casing and counter, which latter was the same as before described. The water entered the revolving drum through the inlet (*a*), and, spreading outward, impinged upon its spiral sides, which yielded to the impact, and allowed the water to issue through two or more outlets at the circumference. The compensating agencies in this meter were two flys or wings (*c c*), which were dragged with the drum through the water, and which retarded the same in a greater measure at high than at low velocities. By this means, and by judicious proportions between the inlet and outlets of the drum, a rate of motion was obtained which was strictly proportionate to the quantity of water passed through, either at a high or low velocity. The principal advantage in this meter over the previous one was, that it had but one step or bearing, which was effectually protected from the water by working in a closed chamber filled with oil. In like manner the chamber containing the reducing gearing was also filled with oil. Of these meters from 200 to 300 had been in operation for upwards of twelve months, and no deterioration had been observed in their working parts. Both these varieties of meters possessed the essential requisite of overcoming casual obstructions, being powerful reaction propellers. In his experience, he had been struck with the powerful effects of concussions in the water-mains, caused by the shutting of sluice-valves. In some instances a thick brass plate, dividing the counter chamber, had been bulged upwards, indicating a pressure of several hundred pounds per square inch. For this reason he doubted very much the success of a piston meter, or, indeed, any meter which intercepted the flow of the water.

Lord BERRIEDALE said that, having heard the explanations relative to these different meters, the Society would now be glad if any gentleman present would give them a few practical hints on the subject, to point out any defects there might be in the meters before them. There could be no doubt that it was of the utmost importance, in order to insure a proper supply of water, that they should have a good and perfect meter. If they went back to the ancients, they would find that the Romans had constructed aqueducts—splendid works of art, of which no description could give an idea—to convey that most important element of comfort, water, to Rome. When he first saw these aqueducts, perhaps he exposed his own ignorance by expressing his astonishment that the Romans had been so ignorant as not to know that water would always rise to its own level. Had he first visited Pompeii, possibly he should never have made that remark. In that city water-pipes were laid down on the same system as in London at the present time, and it was remarkable that they had not yet the advantage of a good meter, by which every person could tell the quantity of water he consumed, and without which they would never get a good and constant supply of water at high pressure in any town.

Mr. YATES had only heard of the intended discussion that morning, or he would have been better prepared to make some observations on the subject. He held in his hand one of

Harrison's water and spirit meters, which was distinguishable by its extreme simplicity. The peculiarity of this meter consisted chiefly in employing the pressure of the fluid to act against two flexible diaphragms placed between chambers, into which it was admitted alternately, and which diaphragms yielded to the pressure alternately in opposite directions, displacing at every movement from the one chamber a quantity of water equal to that admitted into the other. Motion was thus given to spindles, which was ultimately communicated to the slides for the inlet and outlet of the water-spirit, and to the registering and indicating apparatus.

Mr. Chrimes, the manufacturer of Mr. Siemens' meter, produced a small meter, capable of registering 300 gallons of water an hour, which he took to pieces and explained. He stated, that the great difficulty which existed in the construction of a good meter was, to prevent the water getting to the clock-work, which it was liable to do, and thereby destroy its efficiency. In Siemens' meter this was accomplished by the clock-work of the dial being inclosed in a chamber filled with oil, the oil having the effect of preventing the deposit of calcareous or other matter from the water. The price of the meter he held in his hand would be 73*s.*; one measuring 600 gallons an hour, 94*s.*; 1200 gallons an hour, 5*l.* 5*s.*, and larger ones in a similar proportion. In conclusion, Mr. Chrimes stated that 300 of these meters had been at work during the last year, and that there had been no fracture in any one of them, with the exception that eight or ten had been burst during the late severe frost.

Mr. Greaves, of the East London Waterworks, had attended that meeting rather to learn than to instruct; but he might observe, that knowing the value of securing a correct measurement of water, he had made various experiments, with a view of ascertaining how that object might be accomplished. Hitherto, the meters produced had been of two descriptions—the piston and the screw—to which an addition had lately been made by Mr. Siemens' re-action meter, on the principle of Barker's mill, and by that of Messrs. Hanson and Chadwick, produced that evening, neither of which he had as yet tested. The results of his own trials had led him to the conclusion, that for the measurement of small quantities of water, at a low pressure, the piston-meter was the best; whilst for large quantities and high pressure, the screw-meter was preferable. With regard to Mr. Chadwick's meter, he was himself afraid that there would be great friction, and that a variable supply, through a varying pressure on the bags, would be thereby given. He had a tank, 12 feet wide by 3 or 4 feet deep, for the purpose of trying experiments, and though many inventors had brought him their meters for trial, he could not say that he had satisfactory results to communicate to the Society. It appeared to him, that nothing was more easy than to construct a bad meter—but a good one was the difficulty. Nearly every meter he had seen would register the quantity of water consumed with an uniform pressure and draught, but with a varying pressure and draught the result would be very different.

Mr. Mead was rather pleased to hear what had fallen from the last speaker, as his experience of water companies led him to believe that it was not desirable that they should have such a thing as a meter. Water was six times the price of gas, though the companies did not charge it so, not being able to prove the quantities used.

Mr. Harry Chester, as one of the public, expressed his conviction, that it was highly important to the whole population that they should have a good meter, applicable to every house, as by that means alone could they ever expect to get an improvement in the quantity of the water supplied to them. In his opinion, nothing was more absurd or unjust than the system of charging for water according to the number of rooms contained in a house. He did not say that the water companies were conscious of acting unjustly, because they had not yet found out the means by which they could charge every individual according to the quantity consumed. It would appear perfectly ridiculous, were a butcher to charge for his beef, or a boot-maker for his boots, according to the number of rooms a man had in his house; and, in his opinion, the principle upon which water was so charged was equally ridiculous and unfair. It was highly important to the health of the community, that water of the best quality should be supplied to the public, but there was nothing to tempt water companies to improve their supply. Sometimes, under the temporary influence of parliamentary inquiries or other agitation, they heard of various attempts being made to improve the water supply, but when the pressure passed away, the promised improvements passed away also. Under the present system, competition was altogether out of the question, and the consumer was obliged to take his supply of water from any company which had the monopoly of the district in which he resided.

Mr. Fothergill was in no way interested in Mr. Taylor's meters, beyond being consulted by that gentleman, but he knew that, in Manchester, the proprietors of steam-engines had found the meters very valuable as a means of testing the quality of coal consumed by the quantity of water evaporated. A friend of his who had three meters, told him he was saving more than 100*l.* per annum by the experience he thus gained of the quality of coal from different collieries, which enabled him always to obtain a supply from that colliery the coal from which he found to be most economical.

Mr. G. Cape, Secretary to the Lambeth Baths and Wash-houses Company, would not offer any observations upon the merits of the various meters on the table, as he was not an engineer, but would remark that one of the meters upon Mr. Siemens' improved principle was now in work at the establishment of which he was the secretary, and although it had not been tested by Mr. Simpson, the Engineer to the Lambeth Waterworks, from whence they obtained their supply, he believed it worked accurately, and he knew it had passed 1300 gallons in the space of one minute. He thought it fair to state, with respect to Mr. Siemens' meter, that one had been in use at the St. Giles's Baths and Wash-houses for some time, and that it registered to the satisfaction both of the Committee of that Institution and the Waterworks Company that supplied it. The great desirability of an effective water-meter, that would set at rest the discrepancies between the amount of water that consumers imagined they used and water companies that they supplied, could not be over-estimated. As an illustration of the great difference between the quantity of water supposed to be used and supplied, he might mention, that the Lambeth Baths for some four months were obliged to use water without any method of registration; when the calculations came to be made, the Waterworks believed the Baths' Company had used fourteen million gallons of water, and the Baths' Company, after most carefully going into the matter, felt convinced that, at the outside, they could not have used more than eight million gallons. If a correct meter could have been obtained, this great doubt would not have arisen. He merely mentioned this fact to strengthen the assertions of some of the former speakers, who had shown the great want of a water-meter.

Mr. Wright had had more experience with regard to gas than to water meters, though he had invented one of the latter himself. The meters brought before them that evening were of two descriptions—inferential and absolute measurers. Mr. Siemens' was an inferential and not an absolute measurer, the quantity consumed being inferred from that received by the meter. Such an instrument would never do for small consumers, who only required occasional and intermittent supplies, although it would do very well for establishments in which large quantities were used, and where the stream was kept constantly flowing. In order to be beneficial to the public generally, a meter must be an absolute measurer, and he believed that that could best be accomplished by means of a piston-meter. Mr. Taylor's meter was also inferential, and would therefore be equally inapplicable to the wants of small consumers. With regard to Mr. Chadwick's meter it appeared at first sight to be very efficient, and not likely to get out of order; but any practical man, with a very little reflection, would see that there was nothing more probable than that it would do so. In the action of the rollers upon the bags, if any hard substance got under the rollers, it would stop the egress of the water, and destroy the action of the machine. They could not make the holes of any gauze or sieve so small as to prevent calcareous and other deposits passing through with the water. There was no difficulty in measuring the quantities of water supplied to baths and wash-houses, or other large establishments; indeed, that might be done by a force-pump, or by a variety of machinery of a costly description. What they ought to ascertain was, the average price paid for water by each individual per service-pipe. He calculated it at 6*s.* per thousand gallons, which was about 50 per cent. cheaper than gas. The average cost of gas to each consumer was about 3*l.* per annum per service-pipe, and he did not believe that the average consumption of water per individual per service-pipe exceeded 30*s.* per annum, in consequence of the number of small consumers.

Mr. Greaves stated that the price of water was about 3*s.* per 1000 feet.

Mr. Wright said, that that only carried out his argument. The most economical meter produced to them that evening had been stated to cost 73*s.*, and to fix it would probably cost 10*s.* or 20*s.* more. Now, was it likely that any person would go to the expense of 3*l.* or 4*l.* to measure that which would probably not cost half that amount per annum. If fruit was sold in the street, and scales to weigh it were so dear as to double or treble its cost, did they not suppose that the scales would be dispensed with, and the price better djusted by selling the fruit by handfuls? In order to make water-meters available to the general consumer, they must be supplied at a cost not exceeding 15*s.*, while the fitting-up should not incur a further expense of more than 2*s.* or 3*s.* As he had already stated, there would be no difficulty in making a perfect machine for large consumers, but the difficulty existed in obtaining one sufficiently cheap for general use.

Mr. Yates stated, that the meter which he had produced would only cost 35*s.*, whilst it would measure the water with accuracy to half-a-pint.

Mr. Chester asked Mr. Wright whether he did not think that his argument stood equally as much against gas-meters, which were in general use?

Mr. Wright replied in the negative, as the meter in the case of gas, bore a nearer relative price to that of the article consumed than it would with regard to the water. He had supposed that the average price paid per service pipe by each consumer of gas was 3*l.*, whereas for water it was only half that amount, or 30*s.*, and therefore the water meter ought not to cost more than half as much as the gas-meter. He believed that many small cottages did not pay more than 10*s.* per annum for their water, and how could the holders of such houses afford to pay an additional shilling or two for the interest on outlay, and the keeping the meters in repair? The fact was, that water was much lower in price than gas, and any addition to its cost would press heavily on the smaller consumers, who were not also consumers of gas. There was also a greater difficulty in making a cheap water-meter than a cheap gas-meter, as the water would force its way through the stuffing-box, and thereby destroy the action of the index. The price of the gas-meter for two lights was 24*s.*, and 5*s.* or 6*s.* for the fixing; and looking at the relative price of the two articles, the cost of a water-meter ought not to exceed that amount. In reply to a question from Mr. Chester, Mr. Wright said that the tenant either paid for the gas-meter or rented it from the company at 4*s.* per annum, being an addition of 10 per cent, on the lowest charges of about 2*l.* per annum, which would be a very serious impost on the lower class of water consumers.

Mr. Adams was connected with a company for the supply of water to the City of Amsterdam, where they had 24,000 or 25,000 houses to supply. The capital of the company was 200,000*l.* which had been sufficient to buy the land, pay for the engines, and construct all their works. The authorities of Amsterdam, being very desirous of having the water supplied paid for by measurement, he had inspected a large number of meters, and he found that the price would be about 3*l.* each, which would have caused an addition of 70,000*l.* to their capital of 200,000*l.* This would have necessitated a greatly increased charge to the consumer. He found the inhabitants of Amsterdam very ready to take the water, but there was great difficulty in inducing them to pay for the pipes in their houses, and they would not pay for meters; and the company was, therefore, compelled to resort to the old system of the rule-of-thumb, The company had recently sent over one of Mr. Siemens' meters to be put up at the railway works, and he was quite sure that when an available instrument was invented no water company would object to its general application to the houses of its customers.

Mr. Glynn stated, that Parliament had recently insisted that there should be a constant and continuous supply to the houses of the metropolis, and that could not be done without the assistance of a meter. He believed that the discussion of that evening would, by directing attention to the subject, tend to the production of an instrument through which justice might be done both to the consumer and to the supplier.

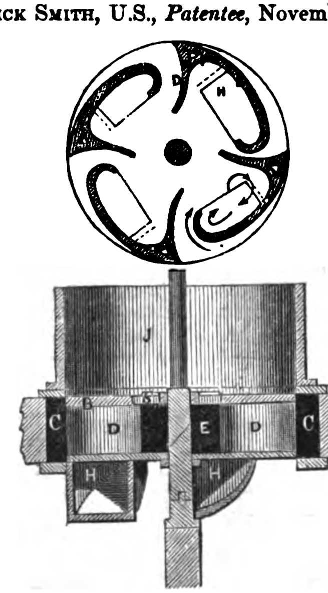
Mr. Foster (the Secretary), to show the injustice of the present system of charging according to the number of rooms, stated that the Society had to pay 8*l.* 8*s.* per annum for their water-rate, notwithstanding that the house was not used as a dwelling, and, consequently, their consumption of water was very small.

Mr. Scott trusted, that when a good system of measuring was discovered, no consideration of expense would stand in the way of its adoption. The necessary arrangements for the supply of water would become a legitimate charge upon the freeholder, as was the drainage of land, and no tenant would object to pay 1*l.* per annum for the benefit of 5*l.*

Lord Berriedale observed, that the objection to the cost of the meters he thought of little moment, as 3*l.* certainly would not go far towards furnishing a house with cisterns, which would be dispensed with by the introduction of the meter, and they would have the advantage of a constant supply of fresh water, whilst it now too often stagnated in the cisterns. He believed that they had very little to complain of in the quality of the water supplied to them, and that if they obtained it constantly fresh, it would be all they could require. He believed that one meter would be amply sufficient even for Buckingham Palace, whilst he could not conceive that one cistern would be of the slightest use in keeping that edifice supplied with water, and therefore there must be a saving between the first cost of meters and cisterns.

## WATER WHEELS.*

Frederick Smith, U.S., *Patentee*, November 22, 1853.




The upper disc B, is open at S, to communicate with the air-tube J, for the purpose of supplying the vacuum with air which the centrifugal force and discharge of the water forms in the wheel around the shaft. The water enters the wheel from the scroll pitch C, C, and acts first upon the buckets D; the water then follows the direction of the arrows along the bucket E, and H, and thence reacting on the bucket H, leaves it. The inventor says in his specification:

"A powerful force assisting in producing the curvature of the current of water as it leaves the inner end of the bucket D, is imparted by the strong draught of air through the tube J. This draught of air rushing into the wheel to supply the vacuum created as aforesaid, and assuming the natural lines of egress consistent with and induced by the arrangement of the wheel and its forces when in motion, acts upon those parts of the wheel over which it passes, producing in a greater or less degree the same effect as the water, thsu giving additional force to the action of the water in its discharge over the buckets H. One of the objects of the buckets E, is to keep the water out to the periphery of the wheel until it acts upon the buckets D. A portion of the buckets D and E, are inclined inward towards the water at the top for the purpose of giving the water a more direct action upon the buckets H, H. By this method of constructing the wheel the water is made to act directly upon the buckets D, D, and then flows round an easy curve previous to being discharged, and is made to act again directly upon the buckets H, H, from which it is discharged in a direction contrary to the motion of the wheel, thus combining the advantages of the impact and turbine wheels more fully than in any other.

* From 'Greenough's American Polytechnic Journal.'

*Direct-Action Screw Engines, designed at the Royal Naval Engineers' Club, Portsmouth.*

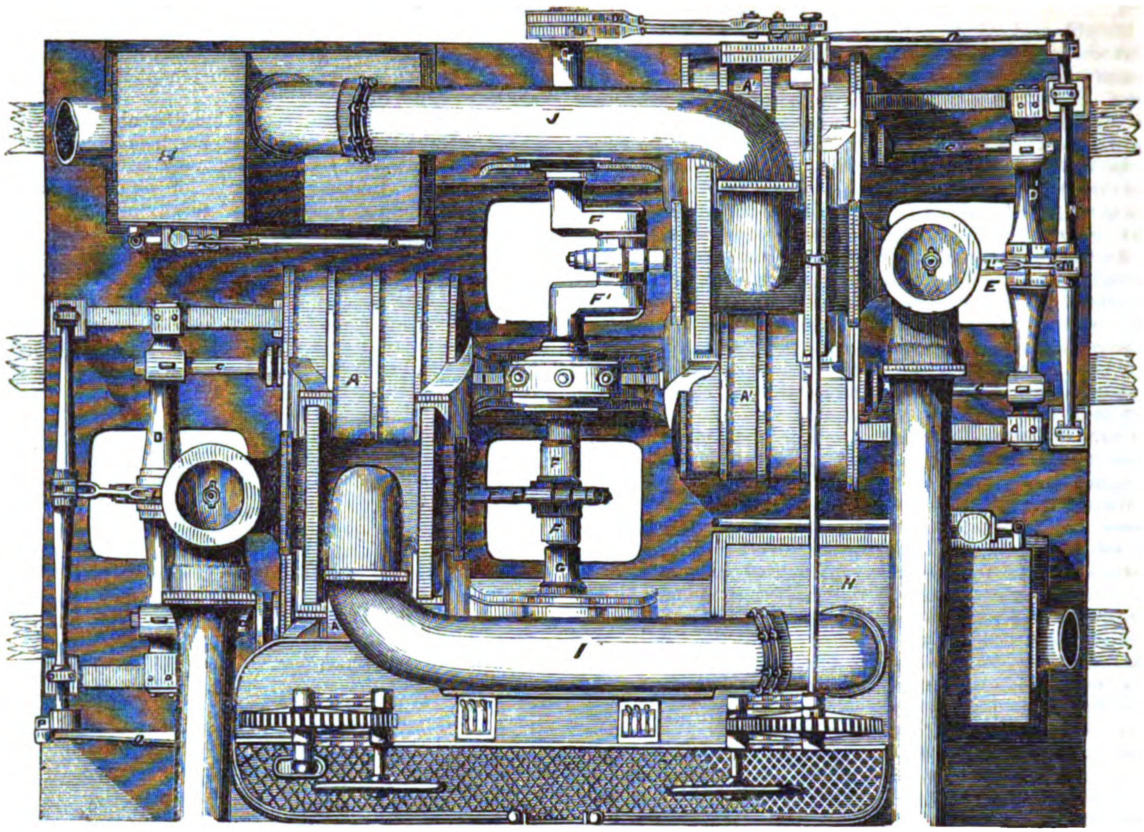


FIG. 1.—PLAN.

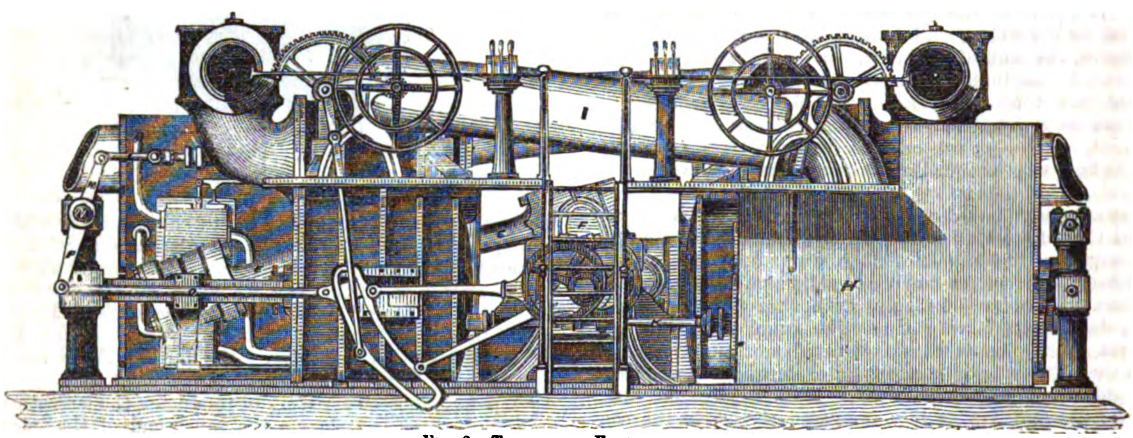


FIG. 2.—TRANSVERSE ELEVATION.

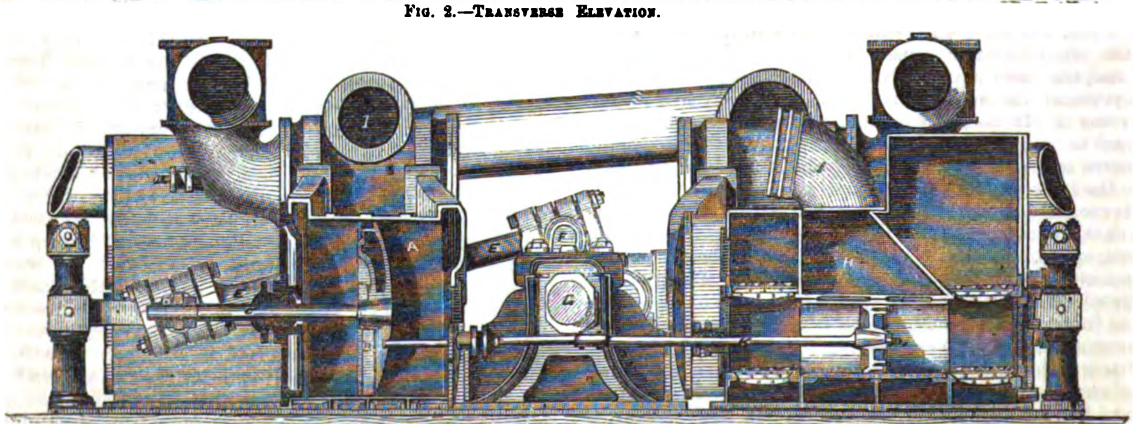


FIG. 3.—TRANSVERSE SECTION.

## DIRECT-ACTION SCREW ENGINES.*

DESIGNED AT THE ROYAL NAVAL ENGINEERS' CLUB, PORTSMOUTH.

It is gratifying to find that some, at least, of the engineers of the Royal Navy are not behind others of their class, in effecting improvements in screw propulsion, as the present invention sufficiently proves. The designers of the arrangement we are now about to bring before our readers do not lay claim to any great originality, their object being to bring together the best parts of all the known engines of the most eminent manufacturers, and to arrange them so as to obtain connecting-rods of greater length than any heretofore employed in such engines, and so as to admit of easy access to, and removal of, any parts that may become deranged, while the space occupied by engines of their construction will not be greater than that ordinarily necessary. The inventors attach particular importance to the increased length of connecting-rod obtained, believing it to be indispensable to the efficient and easy working of the engine, especially for high velocities.

The cylinders are on the principle of Messrs. Maudslay and Field's double-cylinder direct-action engines for paddle-wheel steam ships, but are placed horizontally instead of vertically, and with a different arrangement of the working parts, the cylinders having only sufficient space between them for the introduction of the connecting-rod, the T-cross-heads and lower guides being dispensed with, and the pistons attached directly to cross-heads of the ordinary form. In this manner great strength is combined with simplicity, and means of getting at the cylinder-glands, guides, &c., while under way, as well as at each of the connecting-rod bearings, are afforded. The air-pumps are fitted so as to give easy access to the valves, the pump-rods being worked directly from the piston. The slides, of which there is one for each pair of cylinders, are themselves cylindrical, the interior portion forming the induction pipes, the exhaustion taking place from the exteriors of them. By means of the belt round the slide casings, the required area of steam passage is obtained with a reduced travel of the valve, and a communication between the two cylinders is afforded, and thus the pressures on the two pistons are equalised, and the injurious effects that might arise through leakage are prevented. The feed and bilge pumps are placed between the cylinders, and worked directly from the cross-head, and the expansion-valves are fitted to the end of the slide casing, with the slide-valve passing through its nozzle. The slides are worked by the link-motion, and the arrangement of the starting gear is such, that the engineer is in direct communication with the stoke-hole, and thus has the engines and boilers both under his control at the same moment. The surfaces favourable to the radiation of heat, and those exposed to friction, are not greater than the corresponding surfaces in existing engines, but are, on the contrary, less than in many now adopted for screw propulsion.

The simplification of the arrangement of the working parts of screw engines obtained in this arrangement will be peculiarly favourable to the prosecution of examinations and repairs, giving ample room for these, at every part of the engines, and obviating the necessity of making the cylinders single and of very large dimensions, a practice which it is very desirable to avoid, for large cylinders, when priming to a considerable extent, as is frequently the case, occasion great apprehension and anxiety, and at times cause considerable damage, by bending the piston-rods, splitting the cylinder-covers, &c. We need scarcely add, that these engines will be found peculiarly applicable to all large screw vessels, such as our steam ships-of-the-line, and the Eastern Steam Navigation Company's monster ship of 10,000 tons burden.

The accompanying engravings represent a pair of marine-engines arranged according to this invention, fig. 1 being a plan, fig. 2 a transverse elevation, and fig. 3 a transverse section. A A, are the steam cylinders on one side of the ship. $A^1$ $A^1$, are those on the opposite side. B B, $B^1$ $B^1$, and C C, $C^1$ $C^1$, are respectively the corresponding pistons and piston-rods, the latter of which carry the cross-pieces D, $D^1$. Attached respectively to the centres of these cross-pieces D, $D^1$, are the ends of the connecting-rods E, $E^1$, the other ends of which are pinned to the crank-arms F, $F^1$, on the shaft G. H, $H^1$, are the condensers, of which the former is connected by the pipe I, to the cylinders A A, and the latter by the pipe J, to the cylinders $A^1$ $A^1$. K, $K^1$, are the air-pump rods, of which K, is directly attached to one of the pistons B B, and $K^1$, to one of the pistons $B^1$ $B^1$. The slide-rods L, $L^1$, are worked by the arms M, $M^1$, attached to the axes N, $N^1$, which have a rocking motion communicated to them from the link motions by means of the rods O, $O^1$, and the arms P, $P^1$. The remaining parts of the engines will be readily distinguished, and the arrangement of them understood from the remarks we have already made.

* From the 'Mechanic's Magazine,' No. 1596

## INSTITUTION OF CIVIL ENGINEERS.

*March* 14 *and* 28.—James Simpson, Esq., President, in the Chair.

Portions of these two evenings were devoted to the Discussion of Mr. Yates' Paper, *"On the Advantages of Uniformity in European Weights, Measures, and Coins"* (*ante* p. 154).

Reference was made to the practical working of the proposed change of the present currency to the French decimal system, and the numerous inconveniences to which commerce would be subjected in the re-adjustment of all contracts, debts, exchanges, &c. The intricacy of settling accounts would be infinite, and no corresponding advantage would result. The "franc" shown in the scheme, was not in reality equivalent to the French coin of that denomination; it was tenpence, and all the other coins would be equally fictitious.

Itwas assumed, that the first step towards fixing a decimal system must be the adjustment of the proportional value of the present coins, and eventually of a new issue; a corresponding arrangement of the weights and measures would soon follow. So many propositions of systems had been published, that it seemed as if every person who devoted attention to the subject had tried to invent a new scheme, rather than to devise the method of arriving at a decimal system with the greatest facility and the least derangement of the public convenience.

The following technical points were then considered with regard to coins:—1st. The standard of fineness; 2nd. The relation of coins to the denomination, or money of account, of the country wherein they circulated; and 3rd. The metallic standard.

*First.* The standard of fineness depended on the quantity of alloy introduced in the process of manufacture, or coining. If this were identical in all countries, great trouble would be avoided, but it was argued, that practically such an accordance was scarcely attainable, and in fact, that a table of exchange values met the difficulty of the present discordance.

*Second.* In order to show how difficult of attainment would be an assimilation and interchange of British coins with those of other countries, it was argued that in the United States of America, where the currency was practically based on a gold standard, the eagle, whose value of ten dollars = about 2*l*. 1*s*. English, and the half-eagle = 1*l*. 0*s*. 6*d*. or very nearly the English sovereign, it would be necessary to raise one standard, or to lower the other, in order to do away with the apparent difference of 2½ per cent. now existing, and this would involve the re-coining of the whole circulation of one or the other country, at a certain and great expense, and at the imminent risk of complicating all existing pecuniary engagements. It was urged, that the scheme of assimilating the present coins to the French franc, &c., was equally fallacious; in fact, that the new franc would only be 10*d*. English, and not of the exact value of a French franc, which equalled 9½*d*., and so on for the rest of the proposed series, thus showing a real difference of 4¼ per cent., which was too much to be sacrificed in mercantile or monetary transactions.

The dollar was argued to be equally fallacious as the unit, inasmuch as the various dollars of the several countries, and even of the same country, had different values, and not one of them possessed the precise value of fifty pence English, which had been assumed.

The case of the British North American colonies was quoted, as an example of the confusion resulting from the use of similar denominations of account, without identity of value. The result being, that in no two colonies did the nominal pound represent the same value.

*Third.* That which opposed the most serious obstacle was the metallic standard; there could be no real par of exchange between countries, without a previous agreement as to adopting either a gold or a silver standard, because the relative value of the two metals was constantly fluctuating. The discovery of gold in California and in Australia, followed by an excessive demand for silver for the East, would probably produce great changes; even at this moment, gold was partially displacing silver as a standard in France, where there was apparently in progress a change similar to that which had taken place in the currency of this country during the last century, ending in the final adoption of a gold standard in 1816; and it appeared very probable that gold would become the standard in France, as it was here. It was presumed that the advocates of the franc did not mean to return to a silver standard, as the greatest confusion in the monetary system must be the result.

The pound sterling being now admitted to represent the value of the quantity of gold contained in a sovereign,—all the siver and copper coins being mere tokens, representing certain fractional parts of the pound,—all pecuniary engagements had reference to the pound, and silver was a legal tender only up to forty shillings. It was argued, that the money of account should correspond with the money upon which existing contracts depended, and therefore the pound sterling should be decimalised, rather than attempt a spurious adaptation of the coins of this country to the system of any other nation. Any coins could be used provided their relative value to the integer was well understood, and that integer should not be less than the pound sterling. Wages were calculated in shillings by the artizan,—he knew that twenty of these shillings equalled a pound, and the subdivision of the shilling was of little importance to him, provided the value of the coin was low enough to represent the small articles suited to his means. This was the chief argument against the adoption of the "poor man's useful, precious penny," which had been strongly advocated. If the pound was adopted, the actual value of the present penny being stamped on it, would enable it to circulate without entailing any loss, and the new coins, as they were issued, would bear their correct relative value.

It had been stated, that the proposal of the penny as the integer had received the approval of the Chancellor of the Exchequer, but this was contradicted from authority; no particular scheme has as yet received official sanction. It was admittted, that during the progress of the change to the decimal system, some inconvenience must be experienced and be submitted to, but the embarrassment would not be excessive nor of long duration.

It was urged, that if the value of ten shillings was adopted as the integer, a simple scale of coins would be

| | | |
|---|---|---|
| 10 mils | = | 1 penny. |
| 10 pennies | = | 1 shilling. |
| 10 shillings | = | 1 eagle. |

This, like most of the other schemes for adopting a new nomenclature was disapproved.

It was contended, that the present was an appropriate moment for the proposed change, as there was a somewhat similar movement in the United States of America;—the Zollverein had held a monetary congress, and almost simultaneously there had been a meeting at Brussels relative to the international adoption of Lieutenant Maury's system of naval observations. The simultaneous change of coins, weights, and measures, was therefore urged.

On the other side it was contended, that any rash attempt to adapt the monetary system of this country to that of any other, must be productive of the greatest confusion, and of the most disastrous effects in all mercantile and financial transactions. After reviewing the history of English coins and weights from the period of the Norman Conquest it was shown, that the present gold standard tended to maintain the purity of the coinage; that the franc was not and could not be 10*d.* of the current coin; that the subordinate coins to the sovereign, being only tokens, none of them could be assumed as the integer; that the time was fast approaching, when, in France, the example of America must be followed, and a gold standard must be adopted; that the value of an English sovereign was so generally recognised, that it passed current in almost all countries, especially on the Continent; this might be due, to a great extent, to the care in the manufacture at the Mint and the critical supervision at the Bank of England, where any sovereign having lost more than three quarters of a grain in weight was detained, as being unfit for circulation; this perfection of examination was due, in a great measure, to the weighing and sorting machines of Mr. William Cotton, which had been described to the Institution. The present system being so nearly decimal, it would suffice to declare by Act of Parliament that the pound should be divided into 1000 farthings, and the change would soon work itself, practically, into all commercial transactions; during the transition, the present coins would be stamped with a decimal value; the actual loss would be only a small per centage on the value of present copper coins, and the new ones would at no very distant period displace them. The same process would take place with weights and measures, and in all cases the adoption of a new nomenclature was specially objected to.

The system proposed by General Sir C. W. Pasley in his work on the subject was described, and a statement was promised to be appended to Mr. Yates' paper, by which it was contended, that it was demonstrable that a simplification of the present English coins, &c., would be more advantageous than the adoption of any of the foreign systems, none of which were adapted to the commerce of this country.

After reviewing the arguments of the previous speakers, it was contended that the opposition to the author's views was untenable, as the benefit to be anticipated from the introduction of a decimal system was admitted, and it was only urged against it that it would be impracticable to get all countries to agree. Now, if England and her colonies adopted the system, already accepted in France, and which had made great advances in other continental states, there would be so large a preponderance in commercial transactions, that other countries would soon follow.

As to the anticipated debasement of the standard coin in any country, it was contended, that this would only occur in the event of war, and in violation of the international treaties which it would be necessary to make for establishing identity of values of coinage, and these exceptional cases should not preclude the adoption of a certain benefit. The only instance of such an occurrence, in time of peace, was that of a petty German principality whose coinage being debased, ceased to be received in exchange, and thus the disease brought its own remedy. The case was mentioned of the Zollverein, now including many millions of the German population, and of the *conventions-muntz*, generally passing current throughout the States, where there was a great diversity of coins. The southern States issued their several coins according to an arrangement, which insured an interchange between them; in fact, at Frankfort, coins of all the States were issued indiscriminately by the bankers. How much simpler would it have been to have taken one decimal system for all. If that were done in the case of England, francs and other pieces, bearing the British stamp, would pass as currently everywhere as the French coins were received in Belgium.

It was contended, that the arguments used against the French system of weights, measures, and coins, had only demonstrated its beauty and fitness for nations in all stages of civilisation; and this had been proved by the progress made in its establishment, not only in France, but in almost all countries, when accuracy of observation for scientific purposes was demanded.

It was argued, that any low denomination of coins, such as centimes, might in time be substituted for the *cowries* on the western coast of Africa, of which as much as 1000 tons had been brought in one year to Liverpool, to be re-exported for again trading on the same coasts.

The argument of the national feeling being opposed to fixing upon the franc for the unit, instead of the pound sterling, was urged to be unfounded, as the scale of coins showed that the existing sovereign and most of the other coins were retained for actual public service, when, if necessary, they could be stamped with their decimal value, and these would be used as long as they lasted; thus the new issue alone would be the radical change; and then only when everybody had become accustomed to the system.

It was contended, that in spite of the disinclination to change manifested by some persons, there was a very general desire in the mercantile community to substitute a decimal system of some kind for the present inconvenient mode of calculating; and assuming the French system to be that which had received not only the most careful consideration before adoption, but having now had the advantage of nearly half a century of practice, it was fair to presume it to be preferable to most of the schemes placed by their inventors before the public; and it was argued that the lower classes would have no difficulty in understanding and adopting so simple a system as that used in France.

As to standard measures of length; the origin of the metre was submitted to be more scientific and less rude than that of the yard; and the nautical mile, although very generally accepted in almost all countries, was based on the yard, which was merely an accepted or arbitrary standard, and therefore should not be the basis of a system.

As to weights and measures of capacity; the French system appeared to be based on such a simple and convenient standard, that it seemed impossible not to admit its advantages, and it was contended that no valid arguments had been opposed to it. All the weights and measures were, in practice, divided by the binary system, or into halves, quarters, eighths, and sixteenths, although it had been stated that such a subdivision was incompatible with the decimal system.

As Belgium had legally adopted the French system, and it had been generally received with favour, except in very remote villages, so it had spread to those of the German States most contiguous to France, and as its advantages became appreciated, so would its use be spread more widely. Convenience alone should not be studied for any system; to be perfect, it must possess exactness, convenience, and uniformity; and these attributes, were it was contended, eminently exhibited in the French decimal system.

It was related, that at about the period of the introduction of the sovereign to supersede the guinea, when Mr. Babbage was considering the details of the machine for calculating tables by difference, he essayed every other system, but was obliged to return to decimals; this turned his attention to the means of adapting the English coinage to a decimal scale; his proposition was to accomplish the end gradually, by the introduction of a silver coin of the value of two shillings as the unit,—calling it a "Prince." Then, after a time, to divide the pound sterling into one thousand farthings; other proportional new coins being gradually introduced, as the old coins were withdrawn. The question of the most convenient coins for commercial purposes was entirely apart from establishing the decimal system. These views were repeatedly but ineffectually impressed on the government of the day, but the only publicity given to Mr. Babbage's views was in the second edition of 'The Economy of Manufactures' in 1832. The delay in adopting some scheme of the kind had permitted the issue of nearly eleven millions and a half of half-crown pieces, and so far had interposed greater difficulty in the substitution of decimal coins for those now in use.

It was proposed, as a means of aiding in familiarising the public mind with decimal divisions, to have engraved on all thermometers, the Centigrade, as well as the Fahrenheit scale, so that in time the latter might be dropped and the former be adopted.

It was contended, that for all practical purposes of commere, and for professional and scientific calculations, it would be most convenient to take the sovereign as the integer, to divide it into shillings of the value of ten pence each, and the penny into five farthings; thus, in point of fact, the whole of the existing coinage would be brought as nearly as was practically necessary to a decimal system; and the present coins would be used until they were worn out, and they could be replaced by a new decimal currency.

The objection of the Astronomer-Royal to the adoption of the metre as a standard of length, was contended to be valid; there was no advantage in obtaining a standard from astronomical and other observations; in fact, the present standard yard, as recognised by law, appeared to be sufficient for all practical purposes. His proposition as to the chain and link was not, however, agreed to. On the contrary, it was argued, that by dividing the present foot into 10 inches, instead of 12 inches, and the inch into ten parts, a scale which was familiar to all draughtsmen and to many artizans, would be introduced, which would be easily understood and would soon be adopted. The foot would be divided into 100 parts, instead of into 96 parts; so that $\frac{1}{10}$ might be substituted for $\frac{1}{8}$, with very slight disadvantage. In which case the link of the measuring chain, instead of being represented by 7·92 inches, as at present, would be represented by 6·6 inches, which would be a very convenient proportion for calculation, and it would possess the additional convenience of enabling the superficial inches in a link to be represented by the same figures as those of the superficial feet in an acre; viz., 43·560 inches in one square link,—and 43,560 square feet in one acre.

As to weight, all that could be required was for the legislature to decree, that it would recognise no conventional values for the cwt. or the ton; but that the cwt. should be represented by 100 lb.. and the ton by 2000 lb.; the stone being then 10 lb. The lb might, if necessary, be decimalised, as it was at present by the bullion dealers, for the special requirements of that commerce; but even without that, the chief facilities would be acquired, and practice would soon render the system familiar and convenient.

It was considered of great importance to retain the present denominations, especially for mental calculation, which was so much practised, from the smallest retail traffic up to the most important branches of commerce and financial transactions.

*March* 28.—The discussion was taken on Mr. D. K. Clark's paper, "On Ruthven's Propeller" (*ante* p. 156).

It was contended that there was no novelty in the system of propulsion proposed by Messrs. Ruthven. Benjamin Franklin was among the first to notice it; he related, that as a boy, whilst bathing in a pool into which a wooden pump had been thrown to swell the timber, he got astride upon it and commenced pumping: to his astonishment he found that he was propelling himself across the water; subsequently he investigated the circumstances, and admitted the inefficient application of power. Sir Isambard Brunel attempted propulsion by means of a tube in which there was a diaphragm pushing the water before it, and acting upon a very light valve on the return stroke; this was only an elongated paddle-wheel with an intermittent and inefficient action. Mr. Bidder tried the system also, on board a canal-boat, and although quite aware of the loss of power incidental to it, he expected a compensation from the advantageous application of steam as opposed to animal power.

As to this particular case of Ruthven's and other similar propellers, it was argued that the reasoning in the paper was as totally at variance with the actual results of the experiments as with the received laws of hydraulics. To show this, it sufficed to state that according to the paper, the useful effect realised was 64 per cent. of the power of the engine, stated at 40-horse power (indicated), which would give 25½-horse power useful effect; but it was stated in the experiments that the nozzles were 10 inches diameter each = together $1\frac{1}{10}$ square foot area. The head of water was $8\frac{6}{10}$ feet = to a pressure of nearly 540 lb. per foot, or to a total pressure of about 580 lb., which represented also the resistance of the vessel at 9½ miles per hour, giving therefore a useful effect of 14¾-horse power, instead of 25½-horse power, as stated in the paper.

It was an error to state that the maximum of useful effect was when the velocity of the issuing water was equal to that of the vessel, or when the water dropped vertically from the nozzles; it could be shown that in that particular condition there was not any development of useful effect. The actual operation of the system of propulsion was then shown to be analogous to the assumed case of a closed vessel of any shape, filled with a fluid of given density, and under a given pressure; it was evident, that so long as the vessel remained in that normal state, no propulsive force would be exerted in any direction, the whole being *in equilibrio;* but on an aperture being made in either of the sides of the vessel, it was obvious, that the area of the opening being relieved frrm pressure, the equilibrium would be disturbed, exactly by the extent of that aperture into the head, and there would be a corresponding force exerted in the opposite direction.

To apply this to the case under consideration, a vessel must be imagined, containing water under a pressure = to 3 feet, which was the head due to the velocity of the vessel, in the experiment. By making an aperture of about 3¼ feet area, there would be an unbalanced pressure of about 580 lb., equivalent to that of the former statement; but the velocity of issue would be 14 feet per second, and the power used would be about 15-horse power. But if the aperture was assumed to be reduced to $1\frac{1}{10}$ square foot = the area of the two nozzles; then it would require $8\frac{6}{10}$ feet head to produce the same pressure. The velocity of issue would be 23 feet per second, and the power would be about 25-horse power; thus the power required was exactly in the ratio of the velocity of issue, or inversely as the square root of the head. The loss was therefore 60 per cent. instead of 12 per cent., as stated in the paper.

But the fundamental error in the paper, was the omission of the loss of power arising from picking up the water in a state of rest, and communicating to it the velocity of the vessel. Supposing the water to be composed of an infinite number of globules, possessing weight, and being in a state of rest, they must all be raised to the head due to the velocity of the vessel, and then to the additional head requisite for propulsion. In the present case, the quantity of water issuing from the nozzles was 25 feet per second; this required to be raised 3 feet, to be equivalent to the velocity of the vessel—demanding therefore the exertion of 9-horse power. The results of the experiments would be more correctly stated thus:

| | Horse Power. |
|---|---|
| Useful effect | 14¾ |
| Power consumed in raising the water to the velocity of the vessel | = 9 |
| Power used in propelling the water through the nozzles | = 25 |
| Total power expended, exclusive of the friction in the water-ways and of the engine itself | = 34 |

The absence of indicator diagrams was regretted, as tending to throw a doubt on the results; but it was admitted that the boiler surface, and the actual consumption of fuel, bore out the statements of the paper.

It was contended in reply, that though engine power was consumed in getting the water up to the speed of the vessel, it did not necessarily follow that an equal amount of power was further required to expel the water. This single employment of power could be arrived at by properly forming the water passages, so as to avoid all concussions of the water by rectangular bends, or by sudden enlargements or alterations of form; and the desired object was stated to be, so to proportion the dimensions of the engine and the propeller, that the effluent speed of the water in one direction would be equal to that of the vessel in the other. In this case it was stated, 100 per cent. of the engine power, minus fractional resistance, would be usefully available.

That, practically, there were situations in which such a propeller might be found very serviceable. For instance, in crowded rivers, where paddle-wheels were objectionable, amidst ice, in shallow water where the screw was not available, and in many other situations, where any great projections from the sides of the hull were undesirable. As an example, it was stated that it would be very desirable for the purposes of the Fire Brigade, to have the means of bringing up the large floating-engine at all times of the tide and under all the circumstances of ice, of an encumbered stream, or of shallow water, at a speed of ten miles an hour, propelled by its own engines. Experiments had already been made upon one of the floating-engines, which although very imperfect were sufficient to prove the adaptability of the system to the wants of the Fire Brigade.

In fine, it was contended, that although there still remained much to be done to demonstrate the practical efficiency of so great an innovation, the experiments were sufficiently successful to induce further investigations, and which the author was requested to continue and to report to the Institution.

*April* 4.—After the reading of the minutes of last meeting, it was observed that the statements in the paper on Ruthven's propeller had been misunderstood; as it had been assumed that the paper stated the useful effect realised as 64 per cent. of the whole power of the engine at the pistons; whereas it was really stated to be 50 per cent., and that the useful effect was 64 per cent. of the power delivered to the wheel-shaft: which would materially affect the deductions then made. That one most important element in the calculation was lost sight of, namely, the duplicate pressure of reaction due to the efflux of water through the side of a vessel at rest; the whole unbalanced hydraulic pressure being twice the hydrostatic pressure due to the height of the column of water. It was contended, that this duplicate pressure must exist to some extent so long as the effluent velocity of the water exceeded the receding velocity of the vessel; and that it diminished in some ratio with the receding speed of the vessel, and vanished only when the vessel had acquired the effluent velocity of the water,—when the simple pressure due to the head of water remained. Therefore, that some allowance must be made for this duplicate pressure; and that, assuming it to decrease uniformly with the difference of speeds, the power would be thus estimated when the speed of the vessel was 62 per cent. of that of the effluent water, leaving 38 per cent. of excess:—

$1 \times 100 = 100$ per cent. when the speed of the vessel was equal to that of the effluent water;

$1{\cdot}38 \times 62 = 85{\cdot}56$ per cent. when the speed of the vessel was 62 per cent. of that of the effluent water:

Leaving 14·44 per cent of loss, by excess of speed, as originally deduced in the paper.

It was added, that the proportion of the useful effect would be more simply estimated in the ratio of the squares of the speeds, as was done in the paper, thus:—

$$100^2 : 38^2 :: 100 : 14{\cdot}4 \text{ per cent.}$$

The proposition of the power employed was reduced nearly to common algebra, by separating the various causes and effects: the useful effect, in proportion to the power employed, was shown to be a maximum when the speed of the boat was equal to the velocity of the effluent water, the "vena contracta" being taken into consideration. The ratio of useful effect to power employed was shown to be $\frac{2\ N}{N^2 \times 1}$. The velocity of the effluent water being to the velocity of the boat as N to 1.

It also appeared, that taking the sum of the useful effect, that is, in driving the boat, added to the effect not so employed or wasted, was in all cases equal to the power employed; it was of no importance, theoretically speaking, whether the water was pumped up from the bow, the sides, or the bottom. The subject was investigated in three different ways, each giving the same result.

It was stated, that in 1848 Mr. Purkis being engaged in the construction of a fan-blower, thought the same principle might be adapted to the propulsion of a boat, and tried it in a model, about 4 ft. long and 8 in. wide, with a small engine and two fans, each 2 inches in diameter; with this he attained a speed of three to four miles per hour. He then built another boat 25 feet long, and 4 feet wide, fitted with an engine with two cylinders 4 inches diameter and $4\frac{1}{2}$ inches stroke, driving two fans 12 inches diameter of the same form as the fans of Appold's pump; the water issuing from two orifices, each of 25 square inches. With this apparatus, the boat could only hold her way against a tide of about 3 miles an hour. On the substitution of two fans of 7 inches diameter and the reduction of the propelling orifices to 7·75 sq. inches each, the boat attained an estimated speed of nearly 8 miles an hour. It was admitted that these experiments were imperfect, but they tended to corroborate the statements of the performances of Ruthven's propeller. The arrangement of Purkis' boat differed from Ruthven's chiefly in there being three holes on each side of the vessel—one to propel her ahead,—one astern,—and one midship to supply the pump; each being supplied with a valve to close the orifices not in action, and to act instead of the curved nozzles of the *Enterprise*, which were supposed to be objectional in absorbing power.

*Loysel's Hydrostatic Percolator*.—At this meeting there was exhibited in the library a very simple and ingenious apparatus, designed by Mons. Loysel, for extracting colouring matters from dye-woods, and also for obtaining infusions or extracts of vegetable substances, for medicinal or other purposes. The principle of action was that of direct hydrostatic pressure, applied by a simple and inexpensive apparatus. The substance to be operated upon was placed within a cylinder whose bottom was finely perforated; a similar pierced diaphragm was then placed over it, so as not to produce any pressure; the liquid, either cold or hot, was poured into an upper reservoir, whence it descended by a centre tube to beneath the lower diaphragm, and was forced upwards by the pressure through the superposed substance, every particle of which it saturated in its passage, expelling the air and carrying before it all the finest portions, to the upper strata, against the underside of the upper diaphragm. When a sufficient quantity of liquid had been passed, or the infusion was completed, a cock was opened, which permitted the infusion to return from above, by its own specific gravity, through the substance already operated upon, thus completing the abstraction of any colouring or other matter not previously taken up, and at the same time filtering the liquid. By a second and similar process, anything still remaining in the substance could be extracted. It was practicable, by varying the height of the column, to give any degree of pressure, and by the application of a lamp, or, in a large apparatus, of a coke fire, the temperature of the decoction could be maintained as might be desirable. By another modification, the steam generated in a small boiler regulated the action of the apparatus. The system was described as being adapted to very numerous purposes, and the familiar application of it to making coffee, was exhibited; the apparatus consisted of one vase, either of glass, china, or metal, whose cover, on being reversed, formed the reservoir and pressure column, and in a very few minutes, clear, strong coffee was produced. It was stated, that in an apparatus adapted for a large establishment, four gallons of coffee had been made in twenty minutes. The apparatus appeared to possess the merits of great simplicity, of facility of management, and of being easily cleaned, and the infusion of the substance operated upon was perfect.

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The first Paper read was "*On the Prevention of Smoke in Engine and other Furnaces*." By James Simpson, jun.

The annoyance of smoke incidental to the increase of habitations and to the extension of manufactures, in all cities and large towns, had been noticed reprehensively even as early as the time of Charles the Second, in whose reign it was proposed to legislate on the subject, and in 1697, Dr. Papin devised a scheme for forcing air down a pipe immediately above the incandescent fuel, to induce more perfect combustion.

The attention of parliamentary committees was devoted to the subject in the sessions of 1819 and 20, and again in 1843, when a very complete history of the subject was given in the report, with a clear recapitulation of the scientific evidence, recommending a freer admission of air to the furnaces as the "great, if not the only principle, for preventing smoke." In 1845, two other committees reported, "that opaque smoke issuing from steam-engine chimneys might be so abated as no longer to be a public nuisance;" and in 1853, the "Smoke Nuisance Abatement Act" was passed, and was ordered to come into force in August 1854. This Act rendered it compulsory on owners of engines and furnaces, to provide means for preventing the emission of opaque smoke, and it applied also to steam vessels navigating the Thames above London Bridge.

An enumeration was then given of the local acts into which clauses had been introduced for abating the nuisance of smoke; whence it appeared that there had been an anxious desire to find means of attaining so desirable an end, and the double furnace fired alternately, now so extensively used at Manchester, was alluded to.

The chemistry of combustion was then examined, in order to show that to imperfect combustion alone must be attributed the annoyance, as well as the serious pecuniary loss, now experienced in the emission of opaque smoke from furnaces generally. It was shown that a good furnace should prevent the formation of smoke, by burning all the carbon of the gas evolved; or in other words, by combining at a certain temperature each atom of carbon in the gas with two atoms of oxygen, before it left the furnace: which combination was the best for giving out heat and for evaporating fluids, with the least expenditure of fuel.

The various methods of introducing atmospheric air to the furnaces, and of diffusing it among the gases, were then examined, showing that the admission should be through numerous apertures, so arranged as to permit accurate regulation, as a greater quantity was required after the period of adding fresh fuel than when the fire was burning brightly and freely. The various mechanical means and apparatus proposed for this object were reviewed, and it appeared that in many of them the combustion was to a certain extent imperfect, and the machines were liable to derangement; that the alleged saving of fuel depended chiefly on the manner of stoking, and that it might be attained by a judicious modification of the grate of any well-set boiler, and by a greater amount of attention on the part of the fireman, without any mechanical appliances.

The regulation of the air supply by machinery had been found to fail, in many instances, on account of the variation in the qualities of the fuel, and it was contended that it was more advisable to entrust it to the discretion of the fireman, than to rely upon self-acting apparatus, which might, however, be advantageously used for indicating the state of the furnace.

The employment of Anthracite and Welsh steam coal was advocated, not only on account of the absence of opaque smoke during their combustion, but also on account of the economy arising from their great evaporative power.

The second Paper was "*On the Management of Furnaces, and the Prevention of Smoke*," by C. Wye Williams, Assoc. Inst. C.E.

The object of this communication was to endeavour to remove the mystery which had hitherto obscured what was asserted to be one of the simplest and best understood processes of nature—namely, the combustion of the gaseous products of coal. A short analysis of the chemical details connected with the subject was given, to show that the existence of flame did not imply the combustion of gas. That it was but the preliminary state of high temperature of the numerous atoms of the carbon of the gas which was caused by the intense heat produced by the combustion of the other constituent—the hydrogen.

In effecting the combustion of the gas generated from the coal in a furnace, the first process was merely mechanical, and consisted in bringing the atoms of the gas, and those of the air, into the most intimate state of mixture; such mixture being the *sine quâ non* of subsequent chemical union. The mode or means by which this chemical admixture could be effected, in the most rapid and intimate manner, involved all that art or human ingenuity could do towards producing perfect combustion.

As to the mode of effecting this mixture, or of bringing together the atoms of air and gas, reference was made to the Argand gas burner, as supplying a good illustration: the only difference being, that in the Argand burner, the gas was projected among the air in numerous small jets, or films; whereas, in the furnace, the process was reversed, the air being brought to the gas, in a similar manner, by means of numerous orifices. In both cases the effect was identical, and might be compared to the rose of a watering pot, or of an artificial *jet d'eau*—namely, the producing, on the instant, the largest area of surface for mutual and atomic contact. Models and drawings were exhibited, showing the facility and simplicity with which, both in land and marine furnaces, hundreds of small orifices were introduced, so as to effect the most intimate mingling of the air with the gaseous products of combustion.

It was stated, as the result of considerable experience, that it was a matter of perfect indifference in what part of a furnace or flue the air was introduced, provided this all-important condition was attended to and satisfied—namely, the effecting the mixture of the air and the gas before the temperature of the latter was reduced below that of ascension or kindling. This, according to Sir Humphrey Davy, should not be under 800° Fah., as ignition could not take place at a lower temperature,—that fact being the principle of safety in the miner's lamp.

Previously to the introduction of the tubular in preference to the flue system in marine boilers, it had been supposed that the introduction of the air on the Argand principle, by a perforated plate behind the bridge, satisfied all that nature required in producing perfect combustion. The tubular form of boiler, however, rendered a different arrangement absolutely necessary. This was occasioned by the run, or distance between the bridge and the tubes, being so very short, and consequently, the passing along that distance being so limited in time, that the mixing and combustion could not be adequately effected. This, after numerous trials and expedients, led to placing the orifices of admission in the front, or at the doorway end of the furnace. The system adopted by boiler-makers, of contracting the doorways of marine boilers, much impeded a successful application of the Argand principle. The enlarging the doorway opening, as shown in the models, however, afforded sufficient space for the required number of $\frac{3}{4}$ or $\frac{1}{2}$ inch orifices. By this arrangement, the length of the furnace, from the door to the bridge, was thus, as it were, added to the length of the run. By this mode of construction, the Argand principle had been applied with great success to marine boilers.

The next point considered was, as to the quantity or gross volume of air required, and the area of aperture necessary for its introduction. On this head, it was stated that a great practical error had been frequently committed, as it had been stated that it would suffice if the aperture should be equal to $1\frac{1}{4}$ square inch for each square foot of fire surface in the furnace, in the case of single furnaces; and of but half a square inch or ·5-inch for each square foot of grate-bar surface in the case of double-furnaced boilers. These proportions were now asserted to be wholly insufficient, and in fact were not sufficient to allow of one-fourth the required quantity of air to pass. In practice, it had been ascertained that for bituminous coal, from 4 to 6 square inches were required for each square foot of furnace; and for anthracite, from 2 to 4 square inches, according to the quality of the coals and the amount of draught. The models and drawings exhibited were stated to be conformable to those proportions.

With reference to the supposed necessity for skilful firemen, the paper stated that the only duty that should be required from the firemen was, the keeping the bars fully and uniformly covered; for if the back end or the sides of a furnace were left uncovered, the air would pass through them, instead of passing through the air-distributors, as that passage offered the hottest and shortest route to the chimney. In fact, it was stated, that unless the bars were well and equally covered, it was impossible to regulate or to control the admission of the air.

As to the use of self-acting valves to regulate the admission of the air, it was stated that after numerous plans had been tried during the last ten years, all had been discarded in practice, being found to be worse than useless. The generation of gas, and the admission of the air through the uncovered portion of the bars, created such irregularity as to defeat all efforts at uniformity, and it was impossible, by any self-acting valves, to obviate the effects of such irregularity. It was observed that the pyrometer, a model of which was exhibited in action, proved the inapplicability of such valves, and furnished the only reliable test, as to the quantity of heat produced and properly applied to the generation of steam. It was also observed, that the colour of the products of the furnace, at the chimney-top, was but a source of error,—the sight-holes and pyrometer supplying all that was necessary, and by which the firemen could alone safely and practically regulate the admission of air.

*April* 11.—The evening was entirely devoted to the discussion of the above Papers "On the Management of Engine and other Furnaces, and the Prevention of Smoke." An explanation was given, by means of a diagram, of the several divisions of the process leading to the combustion of the gas in furnaces. The first division gave the mere relative gross bulk of gas and air required for combustion. In the second the mechanical mixture of the gas and air was described, such mixture, or contact of atoms, being essential to the subsequent chemical union. The third exhibited the several constituents of gas and air:—the former being hydrogen and carbon; the latter, oxygen and nitrogen; the relative volumes of each were given, and it was shown that ten volumes of air were absolutely essential to the combustion of one volume of gas. The fourth division showed the proportions in which those constituents combined. The nature of flame and smoke was examined; showing, that the intense heat caused by the combustion of the hydrogen was the direct cause by which the temperature of the carbon was raised to that of white heat, which produced the luminosity of flame. This process was illustrated by reference to the mode of producing the intense heat and luminosity required for the oxy-hydrogen microscope. In the latter, the piece of lime, or carbon, on which the heat was projected, was instantly raised to the temperature of extreme luminosity, neither the lime or carbon, however, suffering rapid combustion. In the former, the carbon of the gas was raised, by the same means (the combustion of the hydrogen), to the high temperature, but could not suffer combustion until it was brought into contact, in its turn, with its equivalent of the oxygen of the air. If, however, that supply of air was not provided before the carbon lost its high temperature, it returned to its previous and natural state of a black substance, and gave the black character to the products, called smoke.

The first important condition was then shown to be, the providing the required quantity of air. Reference was then made to the area recommended by some authorities, as being sufficient to allow the quantity to enter a furnace. It had been considered, that even half a square inch of aperture for each square foot of furnace grate, was sufficient for the combustion of the fuel. This was, however, stated to be insufficient for practical purposes. The proper area for admission being from 4 to 6 square inches for each foot of grate, according to the extent of draught and the nature of the coal. This serious difference was supposed to have been caused by an erroneous calculation of the rate of the current of air entering. For, if half a square inch of area was all that was allowed, the air must have a velocity ten times greater than could be shown to have been ever attained. Thus, supposing a furnace to be 4 feet by 2 ft. 6 in., equal to 10 square feet of bar surface, this would effect a combustion of 2 cwt. of coal per hour, and require for the gas alone, a supply of 10,000 cubic feet per hour, or, for 20 cwt. of the coal, 100,000 cubic feet.

The following comparison of velocities of the entering air for the supply of the gas, gave some idea of the cause of underrating the required area of admission:—

| Air aperture per sq. ft. of grate. | Velocity of draught per second. | Quantity of air per hour. | Quantity for each ton of coal. |
|---|---|---|---|
| 6 sq. inches ... | at 5 ft. per sec. ... | 7,500 cub. ft. ... | 75,000 |
| 6 sq. inches ... | at 10 ft. per sec. ... | 15,000 cub. ft. ... | 150,000 |

then, if the area were reduced to half a square inch, it would require a velocity of 80 feet per second to provide for the admission, within the given time, of the necessary quantity. By close observation, by means of an aërometer, the velocity of the entering current was estimated at from 8 to 10 feet per second if the draught was good, and from 5 to 8 feet when it was but moderate.

Again, it was observed, that by admitting the air through numerous thin films or divisions, the velocity was necessarily reduced by mere friction through so many half-inch orifices as were exhibited in the models and drawings on the table. The mode of admitting the air by numerous small orifices, as practised by Mr. C. Wye Williams, was then considered, and it was shown, that the great object to be effected was the division of the air on its admission to the furnace, so that no more atoms were brought into contact with the atoms of gas, at any one moment, than were required for their successive union and combustion. If this were the case, combustion and heat would be generated, continuously, as the gas and air came into contact. If, however, the air entered in a body, or even in a film, in larger quantities than could be taken up by the gas, before the temperature was lowered, a refrigeratory effect must be the consequence—smoke would be formed and fuel would be wasted.

It was asserted, that the phrase "burning smoke," was improper, inasmuch as the smoke did not exist until the gases had left the furnace; this was demonstrated by a diagram, showing that on distilling coal in a close vessel, and forcing in a small quantity of air, a jet of gas issued, which, on ignition at the orifice, was almost colourless, then merged into flame, and ultimately became opaque smoke.

It was stated, as an argument for the necessity of some stringent measure with respect to the engine furnaces in all large towns, that in the last nine years, between 1845 and 1853, eight hundred and one new chimney-shafts had been erected in the metropolis, for manufactories, breweries, &c. Some few of them might have been merely rebuilt after destruction, but the large majority caused additional impurity in the London atmosphere. From 1845 to 1851 the greatest number built, in one year, was ninety-nine; but in 1852 one hundred and eleven were constructed, and in 1853 the number rose to one hundred and twenty-three.

It was contended, that in dealing with the smoke question, too much stress had been laid on the chemical part of the subject, as also, that the statement of its being "impossible to burn smoke" had complicated that which was in itself a simple question. All that the public cared about was, that by some means the black or brown visible smoke should be prevented from forming, or be consumed if its formation was incidental to perfect combustion. The air necessary to perform this could be admitted anywhere; either through a split bridge,—by the fire-door,—by an infinite number of holes,—between plates with narrow spaces,—or by others arranged like Venetian blinds. Practically, the end could be attained by the mechanical systems of Juckes, Haseldine, Hall, and others, or by the double-furnace boilers of Galloway, Rose, McGavin, and others, or by the systems of Williams, Prideaux, and many others.

The objections alleged against all these plans were illustrated, and it was stated that with ordinary boilers, the admission of air invariably reduced the evaporative power, or caused waste of fuel, unless there was a sharp draught and spare boiler power; but that when these latter requisites were secured, the air might be admitted in any way practically found most convenient.

The arrangement proposed by Mr. Prideaux was noticed as the most creditable mechanism yet brought forward, but its neatness was its only recommendation, as it could not improve the draught, nor could it aid in "burning smoke" better than would be done by merely leaving the furnace door ajar. The remarkable coincidence, between the arrangement of the parallel plates in Prideaux's fire-door, and that of Williams' well-known and long-practised system was also noticed. It being stated, as fundamental principles, that in the former system, "the door of the furnace should be double, and the air should pass into the furnace through a series of perforations in the inner plate. By this arrangement, three important results are secured.—1. The heating of the air.—2. Its subdivision into minute jets. (This is the precise principle and operation of Williams' argand furnace.)—3. The keeping of the outer surface of the furnace-door comparatively cool, and thereby both economising heat and preventing its radiation outwardly, to the annoyance of the attendants."

Drawings were exhibited of a double flue and double furnace-boiler, whose action was stated to be very satisfactory; the proportion of air space provided in that case was one square inch to each square foot of grate area. The admission of too large quantities of cold air immediately behind the bridge had been found prejudicial, and the system of admitting the supply of air through the perforations in the fire-door was generally preferred. The system of alternate firing, and of having ample boiler space and good draught, was insisted upon.

It was stated, on behalf of the mechanical methods of firing, that at Price's candle manufactory, at Vauxhall, three methods, Jucke's, Hazeldine's, and Hall's, were employed with success. The general principle, of a continuous supply of fuel at the front of the fire, by means of moving bars carrying the coal forward, was common to all these apparatus. The air was admitted only from below and between the bars, which were always covered with fuel. The objections urged against these machines were, the first cost and their liability to derangement. These, however, were now diminished, particularly with those of Juckes and Hazeldine, to which preference was therefore given in the construction of new furnaces. They were found to produce almost perfect combustion, and to make a great saving of fuel with other practical advantages.

Two cases were mentioned, as illustrative of the necessity of admitting the air above the incandescent fuel—the first was that of the ventilating furnaces in pits, where it was essential to raise, to a certain temperature, the largest amount of air, by passing it through or over the fuel in a furnace, in such a manner as to render the air as light as possible, and not to encumber it with smoke;—the second was that of coke ovens, which were now constructed in pairs, and were worked alternately, in such a manner that the early smoke from one oven mingled with the later development of gases from the other oven;—by this means the appearance of any opaque smoke was entirely prevented.

In reply to the arguments in the papers, and to some of those used by the speakers, it was urged, that even with the best construction of furnaces, skilful firemen must be employed, and that it was desirable the subject should be divested of all complexity, and should be rendered clear to the meanest capacities. Instances were given of the advantageous employment of mechanical methods of stoking, particularly at the brewery of Messrs. Truman, Hanbury, and Co., where sixteen sets of Juckes' apparatus had been used for several years, and had induced a great saving of fuel, as well as insured undeviating regularity of temperature in the furnaces. The self-acting systems practised by Brunton, and by Parkes, many years since, were alluded to, and the reasons for their use being discontinued, were given; the alleged defects of these systems where shown not to exist in the apparatus of Juckes, Hazeldine, and Hall, but that even they were up to this time unfit for use in steam vessels, where it had been imagined that mechanical means of firing would have been most advantageous, but where in reality the heat in the furnaces was so intense as to destroy any machinery attached to the fire-bars. The success attendant on Mr. Houldsworth's system for preventing smoke, and on his invention of the metal rod pyrometer, was described.

The general result of the investigation appeared to be, that, although for certain large establishments the mechanical methods of firing were successful, it could not be expected they would be adopted for every furnace in the smallest manufactory; therefore, a good system of mingling a due proportion of atmospheric air with the gases evolved during combustion, was essential, and the method employed by Williams appeared to fulfil the required conditions.

## CELTIC MONUMENTS IN IRELAND.

Many an English traveller who has visited Egypt, would in all probability be surprised to learn that, comparatively speaking, at his door, there exists a monument which, as a writer whose name I cannot recall, says, if built on the banks of the Nile instead of the Boyne, would be considered one of the oldest of the Pyramids. At a short distance from the town of Drogheda, the three great mounds of New Grange, Knowth, and Dowth present themselves to view, at the distance of about a mile from each other; and the casual observer would probably look upon them as great natural hills, one of which is covered with wood, and another having had until lately a stone building on its summit. Those, however, who have examined the structures of ancient times at once perceive the artificial character of these vast pyramids.

The monument of New Grange consists of an enormous cairn, or hill of small stones, occupying the top of a slope to the north of the river Boyne. It covers something less than two acres, and is at the present day about eighty-feet higher than the adjoining surface; but its height, as well as the beauty of its outline, has been lessened by the excavations made at different times into its sides and upon its summit, for the purpose of obtaining materials for building and road making. Ten large blocks of stone still remain of the circle which, apparently, surrounded the mound in ancient times, and it is said that a great pillar of stone once crowned the summit.

The writer visited this monument of the Celts about two years since, and penetrated into the interior, having previously procured a lighted stick and a candle. The entrance is formed by large flags, and a singularly carved stone, sloping outwards, ten feet long and about eighteen inches thick, attracts attention from the spirals and volutes cut upon it. A narrow passage formed of stones of great size gives access to a large chamber constructed of stones of enormous magnitude. Some of the stones were probably taken from the bed of the Boyne, but the rock of which others are composed is not to be found in the neighbourhood. All the great stones of the passage and chamber must have been transported from a distance, although the smaller ones forming the greater portion of the hill may have been procured on the spot. The passage, formed of upright stones and covered with enormous flags, is sixty-three feet long, and about six feet high, although at the entrance it is somewhat lower, and as it nears the chamber it rises to the roof; some of the stones have fallen inwards, but in general it is three feet wide. When I reached the chamber, I blew upon the lighted stick, and lit the candle. After a moment I could perceive through the thick darkness that reigned in this mysterious chamber, a grand dome-shaped roof, tapering to a centre, and three recesses or crypts formed of enormous blocks.

I cannot at present give descriptions of the rude carvings cut into the stones, and sometimes standing out in relief, but the reader who is curious about such matters will find much interesting information, together with the necessary illustrations, in Wild's 'Beauties of the Boyne,' which work I have consulted in giving the above details. I must not omit to mention, however, a remarkable circumstance which struck that gentleman when investigating this ancient structure. He found that the carvings extended over those surfaces of the stones which had been completely hidden from view, and he infers that they were carved before occupying their present position. A portion of the chamber opposite the entrance having fallen in, part of the under surface of a great flag has been exposed to view. It has, like most of the other stones here, a brownish outer polish. In the exposed carvings, the indentures have assumed more or less of the dark colour and polish around, but in this instance the marks of the tool are here as fresh as if done but yesterday.

There is a large oval stone, hollowed like a basin, in each of the recesses; the one in the right-hand chamber is three feet long, and stands upon another basin, while the other chambers have only one such sarcophagus.

A comparison with the Egyptian pyramids will suggest itself to every one,—their central chamber, with one or more sarcophagi, and long entrance passage. A series of chambers, which Mr. Wild compares to those found beneath the great central chamber in the largest pyramid of the Sakkara range, has been explored in the mound of Dubhadh, or Dowth. As there is no access to the interior of the remaining mound, the comparison cannot be continued further for the present. It is a curious fact, however, that among the other carvings at Dowth, the lotus, or lily leaf, is represented most accurately in relief. E. P. H.

## NEW PATENTS.

### PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAW AMENDMENT ACT.

*Dated December 17, 1853.*

2945. J. S. Cockings, Birmingham—Improvements in buttons and other dress-fastenings; part of which is also applicable for other purposes

*Dated December 21.*

2971. J. Jones, Glasgow—Improvements in propelling vessels

*Dated January 16, 1854.*

102. G. F. Wilson, Belmont, Vauxhall—Improvements in treating castor-oil, and obtaining products therefrom

*Dated January 18.*

123. R. Galloway, Lambeth—Improvement in admitting air to furnaces where tubular boilers are employed

*Dated January 19.*

127. J. Spiller, Battersea—Improvements in measuring and mixing, crushing, grinding, and pulverising wheat and other substances

*Dated February 20.*

399. R. C. J. Prevet, Paris—Improvements in treating textile plants for obtaining pulp for manufacturing paper

*Dated February 23.*

436. C. Walker, Bury, Lancaster—Improvements in purifying water for steam-boilers

*Dated February 24.*

449. R. J. Green, Birmingham—Improvements in the manufacture of corrugated elastic materials

456. A. E. L. Bellford, Castle-street, Holborn—Improvements in turn-tables for railways. (A communication)

*Dated February 27.*

470. E. Chappuis, St. Mary Axe—Improved apparatus for the diffusion of light, called "Illuminators."

475. R. A. Brooman, Fleet-street—Improvement in the manufacture of tinfoils or sheets. (A communication)

*Dated February 28.*

478. T. Denny, Strasbourg, France—Improvements in engraving

483. W. Simpson, Tovil Upper Mills, near Maidstone, Kent—Improvement in employing in the manufacture of soap a product obtained when manufacturing pulp from straw

*Dated March 3.*

517. J. A. Boyle, Alfred-place, Bedford-square—Crushing or reducing to powder, pulp, or wash, any matter.

*Dated March 4.*

525. E. Rowland, Manchester—Improvements in machinery or apparatus for manufacturing bricks or tiles from clay or other plastic materials

529. F. Abate, George-street, Hampstead-road—Improvements in printing on and ornamenting surfaces

531. F. H. Wenham, Effra-vale Lodge, Brixton—Improved hydraulic machine for registering or indicating the flow or quantity of fluids, and obtaining motive power

*Dated March 6.*

535. J. Galloway, Bolton-le-Moors, Lancaster—Improvements in the construction of cocks, taps, and valves

537. S. A. Chapin, Trafalgar-square, Westminster—Improved mode of purifying smoke produced by the combustion of coal or other substances, and for condensing and collecting the solid and other matters contained in smoke and vapour arising from the combustion, smelting, burning, or roasting of fuel and other substances. (A communication)

539. J. Ronald, Patrick Bank, near Paisley—Improvements in printing yarns and threads

541. J. R. Morton, Oxford-street—Improvements in shades and reflectors applicable to certain descriptions of lamps, lanterns, or chandeliers

*Dated March 7.*

543. J. Johnson, Church-street, Leatherhead—New stop for railway and other carriages

545. F. Rixon, Cockspur-street, Westminster—Improved apparatus for lowering and disengaging ships' boats

*Dated March 8.*

547. T. Dunn, Pendleton, Lancaster—Improvements in machinery and apparatus for moving engines and carriages from one line of rails to another, and for turning them

548. H. B. Barlow, Manchester—Improvements in waterproofing and finishing textile fabrics and yarns. (A communication)

550. G. Beardsley, Coal-pit-lane, Nottingham—Improvements in round or circular machinery for the manufacture of textile and looped fabrics

551. R. Boyell, Derby-road, Nottingham—Portable safety-guard for the prevention of fire, applicable alike both to public and private buildings, and which said portable safety-guard is also applicable as a reviver.

552. J. D. Brunton, Truro, Cornwall—Improvements in wind-guards or chimney-tops, for promoting ventilation in coal-mines

553. W. I. Cookson, Newcastle-on-Tyne—Improvement in the reduction of lead ores

555. W. S. Losh, Wreay Syke, Cumberland—Means of decolouring resins

556. G. Devincenzi, Grosvenor-street—Improvement in producing ornamented and figured surfaces, and surfaces for printing from

557. J. Aitken, Longsight, near Manchester—Improvements in obtaining motive power

558. W. Warne, Lower Blowing House, St. Austell, Cornwall—Improvements in tubular steam-boilers or generators

559. J. Brown, Leadenhall-street—Improved method of swinging furniture and other articles for travelling by sea or land, and other purposes

560. J. Blair, Irvine, Ayr—Improvements in beds or couches, and other articles of furniture

*Dated March 9.*

561. W. W. Good, Moorgate-street—Improvements in machines applicable for thrashing or winnowing

563. G. T. Selby, Smethwick, Warwick—Improvements in machinery for the manufacture of tubes and pipes, and for shaping tubular and certain metal articles

564. J. H. Johnson, Lincoln's-inn-fields—Improvements in machinery or apparatus for finishing fabrics. (A communication from D. P. Pepin and A. Roy)

565. W. B. Johnson, Manchester—Improvements in strengthening the ends of tubes to be attached to boiler-plates, or to be used for other such purposes

566. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improved reaping machine. (A communication)

567. W. Young, Queen-street, Cheapside—Improvements in lamps

568. J. H. Swan, Glasgow—Improvements in the tuyeres of blast and other furnaces and fires

569. F. E. S. Garnier, Paris—Improvements in machinery for preparing flax and othe textile materials

570. H. Lamy, Paris—Improvements in preserving animal and vegetable substances

*Dated March 10.*

572. E. A. Desrousseaux, Roubaix, France—Improvements in looms for weaving

573. W. Peace, Haigh, Lancaster—Improvements in machinery for measuring, indicating, and registering the flow of air, gas, and other liquids, and for governing the speed of steam or other engines

574. S. Moseley, Hull—Improvements in the manufacture of artificial palates for the adaptation of artificial teeth

575. J. Lawrence, Leeds—Improved rotatory engine

576. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in the manufacture of candles. (A communication)

577. J. Buchanan, Leamington Priors, Warwick—Improvement in communicating motion to or from the ordinary crank or an eccentric.

578. W. Day, Beverley, York—Improvements in the construction of covered carts and other like vehicles, which may be used as dwelling-places or travelling-houses

579. F. Whitehead, and W. Whitehead, Crayford, Kent—Improvements in raising, forcing, and supplying water and other liquids

580. W. Mill, Hunter's-lane, Birmingham—Improvements in inkstands or ink-holders

581. A. V. Newton, Chancery-lane—Improvements in the manufacture of raised printing surfaces. (A communication)

582. A. V. Newton, Chancery-lane—Improvements in the mode of purifying coal-gas, and of obtaining during the manufacture of the gas a certain purifying material, and in apparatus to be used in purifying gas. (A communication)

583. D. P. Lefevre, Paris—Improved railway-break

584. Z. Boitteux, Epinal, France—Improvements in the machinery for sculpturing and carving

586. J. Patterson, Beverley, York—Improvement in machines for washing cloth and similar materials

587. J. H. Johnson, Lincoln's-inn-fields—Improvements in the manufacture of hollow jewellery. (A communication from J. M. Payen)

*Dated March 11.*

589. J. Maynard, Drury-lane—Improvement in strings for pianofortes and other stringed musical instruments

590. W. T. Monzani, St. James's-terrace, Bermondsey—Improvements in bedsteads and packing-cases or boxes to contain the same and other articles

591. J. Wright, Manchester—Improvements in machinery or apparatus for "curing" and "liquoring" sugar by centrifugal force, without acidifying or injuring the syrup. (A communication from J. Reid, Jersey, U. S.)

592. W. Tytherleigh, Birmingham—Improvements in the manufacture of tea-kettles

593. W. Symington, Gracechurch-street—Improvements in apparatus for heating air by means of steam

595. J. H. Johnson, Lincoln's-inn-fields—Improvements in lighting. (A communication from A. Martin, Paris)

596. J. Sparrow, jun., Tettenhall-road, Wolverhampton—Improvements in shears for cutting iron or other metals

597. J. Buchanan, Leamington Priors, Warwick—Improvements in the propellers and apparatus used for propelling vessels

*Dated March 13.*

598. L. Whitaker, J. Diggle, and G. Howorth, Haslingden, Lancaster—Improvements in machinery or apparatus for spinning cotton and other fibrous materials

599. J. H. Johnson, Lincoln's-inn-fields—Elastic breeching apparatus for cannons. (A communication from G. M. Knevitt, New York)

600. B. Latchford, St. Martin's-lane—Improvements in saddlery or harness

601. J. Glenny, Strand—Portable camp-bed

602. E. Haeffley, Radcliffe, Lancaster—Improved mordaunt to be used in printing and dyeing textile materials and fabrics; applicable also to the process of bleaching

603. E. Haeffely, Radcliffe, Lancaster—Improvements in the manufacture of stannates of soda, potash, and ammonia

604. J. Wright, Park-street, Kennington—Improvements in the construction of furnaces for the purpose of consuming more effectually than heretofore the smoke contained therein

605. J. Walker, City-road—Improvements in raising stamps employed for crushing, and rams or monkeys employed in pile-driving and other like operations

606. G. Hopper, Houghton-le-Spring Iron Works, Durham—Improvements in pins for railway-chairs

607. J. H. Johnson, Linclon's-inn-fields—Improvements in sewing-machines. (A communication from A. E. Figuier and E. Cherault, Paris)

608. A. E. L. Bellford and P. Ristori, Castle-street, Holborn—Improvements in inflating life-belts, buoys, and articles of a similar nature. (A communication)

*Dated March 14.*

609. F. Russell, Clarence-gardens, Regent's-park—Improvements in apparatus for clearing obstructions on railways

610. A. W. Conner, Crooked-lane, Cannon-street—Improvements in the apparatus used for moulding bricks and lumps

611. J. H. Swan, Glasgow—Improvements in drying bricks, tiles, and other articles made of brick-earth

612. J. Hands, Epsom—Improvements in kilns

613. J. Woodford, Hatton-garden—Smoke-consuming rotary grate

*Dated March 15.*

614. R. A. Brooman, Fleet-street—Improvements in sector presses. (A communication)

615. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in producing waterproof stuffs. (A communication)

617. T. Kaye, Huddersfield—Improvements in the manufacture of gas, and in the apparatus employed therein

618. T. S. Holt and C. H. Holt, Manchester—Improvements in steam-boilers

619. J. P. Oates, Lichfield, Stafford—Improvements in the manufacture of bricks, tiles, pipes, and such other articles as are or may be made of clay

620. L. Whitaker and G. Lyons, Haslingden, Lancaster—Improvements in grinding or setting the main cylinder of carding-engines used for carding cotton and other fibrous materials

621. J. Houston, jun., Glasgow—Improvements in working steam-boilers, and in apparatus connected therewith

622. A. Trueman, Swansea, Glamorgan—Improved furnace for the calcination of copper ores and other mineral substances

623. W. Weatherley and W. Jordan, Chartham, near Canterbury—Improvements in steam-boilers

624. A. E. P. Legros, Paris—Improvements in preserving timber, and generally all kinds of wood

625. T. W. Keates, Chatham-place, Blackfriars—Improvements in the means of distilling tupentine and other resinous matters, and in manufacturing boiled or drying oils

626. G. Pead and C. Wyatt, Conduit-street, Regent-street—An instrument for readily ascertaining the wear of the bearings of railway carriages

627. M. Binns and J. Pollard, Bradford, York—Improvements in apparatus for combing wool, cotton, silk, flax, or other fibrous substances

*Dated March 16.*

628. C. Poisson and L. J. Martin, Paris—Improvements in printing fabrics. (Partly a communication from H. L. Talle, Paris)

629. R. Weare, Princes-road, Woolwich—Improvements in the construction of galvanic batteries, and in apparatus connected therewith

630. D. Bethune, Toronto, Canada West—Improvements in the construction of vessels propelled by steam

631. F. W. Emerson, Trereiffe Chemical Works, near Penzance, Cornwall—Improvements in machinery for pulverising, washing, and amalgamating quartz, and matters containing gold and silver
632. J. Cavanah, Liverpool—Improvements in sails for navigable vessels, and in the apparatus for working them
633. J. Lilley, Birkenhead, Chester—A new material, suitable for spinning either alone or combined with other fibres, and suitable to the manufacture of pulp; also certain machinery employed in the preparation thereof
634. J. G. Marshall and P. Fairbarn, Leeds—Improvements in machinery for combing flax, tow, wool, hair, and other vegetable or animal fibres

*Dated March* 17.

635. J. Gerard, Guernsey—Macninery for cutting and stamping soap
636. W. Holt, Bradford—Improvements in reed-pipes for organs
637. R. W. Harris and T. Patstone, Birmingham—Improvement or improvements in shades or glasses for gas and other lamps
639. T. W. Scott, South Devon-place, Plymouth—Improvements in the preparation or manufacture of Devonian limestone
640. A. Hendry, Port-Glasgow, Renfrew—Improvement in heating bakers' ovens
641. G. H. Barth, Mornington-crescent, Hampstead-road—Improvements in the mode of supplying and administering gases for the alleviation and cure of certain diseases
642. T. Basnett, Liverpool—Improved mode of compensating for the deviation of the needle of ships' compasses occasioned by local attraction
643. J. Hughes, Bethnal-green-road—Improved mode of operating the Jacquard apparatus of looms employed in figure weaving

*Dated March* 18.

644. G. W. Reynolds, Birmingham—New or improved fabric to be used in the manufacture of stays or corsets
645. J. Hyde and J. Harpur, Stockport, Chester—Improvements in the construction of spindles and flyers for roving and slubbing frames
646. J. Hick, Soho Iron Works, Bolton-le-Moors, Lancaster—Improvements in apparatus for heating the cylinders of steam-engines
647. W. Thorne, Barnstaple, Devon—Improvements in reducing metallic ores
648. W. Dantec, New Quay, Liverpool—Improvements in purifying water
649. P. M. Parsons, Duke-street, Adelphi—Improvements in the construction of the permanent way of railways

*Dated March* 20.

650. P. R. Hodge, Moorgate-street—Improvements in reducing metallic ores
651. E. de Mars, Paris—Improvements in windlasses or capstans. (A communication from F. Femé)
652. R. Tempest, J. Tomlinson, and H. Spencer—Improvements in the method of cleansing sheep's wool, and in the machinery or apparatus connected therewith
653. J. Bird, jun., Manchester—Improvements in the manufacture of silk into threads required for woven fabrics, for sewing and for other purposes, and in machinery to be used for these purposes
654. H. Moore, Junction Foundry, Hull—Improved template for facilitating the building of iron ships and vessels
656. F. Loret-Vermeersch, Malines, Belgium—Improvements in looms for weaving
657. J. Horton and R. Polglase, Stepney—Improvements in the construction of ships' boilers, girders, tanks, gasometers, and other like structures or vessels
659. W. L. Webb, New Broad-street—Improvements in pulverising, washing, and amalgamating quartz, and matters containing gold and other metals
660. J. Longbottom, Leeds—Improvements in combining atmospheric air with hydrocarbons for the purposes of light and heat. (A communication)
661. J. Perkins, Kennington—Improvements in metallurgy, especially applicable to the production of type and ornamental forms.
662. J. Perkins, Kennington—Improvements in working metals, especially adapted for producing surfaces for blocks for printing calicoes, silks, paper, and other fabrics
663. J. Young, East Smithfield—Improvements in brewing
664. R. A. Brooman, Fleet-street—Improvements in sewing-machines. (A communication)

*Dated March* 21.

665. W. Stevens and W. Stevens, jun., Birmingham—New or improved machinery for grinding and polishing lenses
666. J. D. Pfeiffer, Rue Princesse, Paris—Improvements in book-binding. (A communication)
667. J. Hansor, Wandsworth-road—Improvements in the manufacture of illuminating gas
668. J. Polson, Paisley, Renfrew—Improvements in the manufacture of starch

*Dated March* 22.

669. R. Roberts and G. Coppock, Heaton Norris, Lancashire—Improvements in looms for weaving
670. A. V. Newton, Chancery-lane—Improvements in japanning leather and other fabrics. (A communication)
671. E. Keirby, Radcliffe-close, Manchester—Improved reed for looms
672. J. Sheringham, Edwardes-square, Kensington—Improvements in the construction of kettles and other like domestic utensils, and in the means of supporting or retaining the same in proper position when in use
673. W. Fast, Goswell-road—Improved ventilator
674. G. Sterry, Worcester—Improvements in the manufacture of mouldings, suitable for cornices, picture-frames, architectural decorations, and other like purposes
675. H. Maderson, Clapham, and G. W. Warren, Lambeth—Improved safety-guard for gun-locks
676. T. S. Watson, West Strand—Improved railway-traverser
677. J. Healey, J. Foster, and J. Lowe, Bolton-le-Moors, Lancaster—Improvements in certain parts of machines used for preparing, slubbing, and roving cotton and other fibrous materials
678. J. H. Robinson, Hebden-bridge, York—Improvements in steam-boilers
679. W. D. Skelton, Leeds—Improvement in preparing flax for spinning
680. R. O. White, Swanscombe, Kent—Improvements in the manufacture of Portland cement

*Dated March* 23.

681. B. England, Leigh, Lancaster—Improvements in the manufacture of woven fabrics, and the machinery or apparatus employed therein
682. E. D. Coës, St. Denis, France—Improvements in the preparation of certain substances for the purpose of printing and dyeing fibrous materials and fabrics
683. W. V. Greenwood and J. Saxby, Brighton—Improvements in railway signal-lamps
684. F. Seiler, Interlaken, Switzerland—Improvements in the manufacture and construction of solid and veneered tesselated, and other shaped woodwork, suitable for floorings, buildings, works of art, and other purposes
685. L. Whitaker and Dr. Ashworth, Haslingden, Lancaster—Improvements in power-looms for weaving
687. A. Lister, Birmingham—Improvements in the manufacture of metallic castings
688. J. Newman, Birmingham—Improvements in the manufacture of metallic tubes
689. S. Holman, Colney Hatch—Improvements in machinery for raising and forcing fluids; part of which improvements is also applicable to the guiding of piston-rods generally, and other rods

*Dated March* 24.

690. R. Montgomery, New York—New and useful improvement in corrugated metals, and in machinery for producing the same
691. H. Room and W. Morton, Birmingham—New or improved method of ornamenting metallic bedsteads, and such other articles of furniture as are or may be made of metal
692. R. Doidge and J. Cloves, Birmingham—Improvement or improvements in the manufacture of rolls to be used in shaping and impressing sweetmeats and plastic materials generally
693. B. Fothergill and W. Weild, Manchester—Improvements in obtaining and preparing the fibres of plaintain, penguin, and other vegetable substances for manufacturing purposes
694. S. Humphreys, Green-street, Leicester-square—Improved apparatus for the heating or distilling of fatty, oily, and resinous matters. (A communication)

*Dated March* 25.

696. W. Wood, Monkhill-house, near Pontefract, York—Improvements in machinery or apparatus for the manufacture of carpets and other fabrics
697. E. Bagot, Llaneley, Carmarthenshire—Improvements in the manufacture of rails for railways
698. J. Lochead, Kennington, and R. Passenger, Union-street, Southwark—Improvements in the manufacture of glass or other vitrified substances
699. J. Robertson, Glasgow—Improvements in lifting or transporting heavy bodies
700. W. Neilson, Glasgow—Improvements in marine steam machinery
701. T. Gibson and W. Knighton, Stavely Works, Chesterfield—Improvements in moulding and casting metals
702. T. J. Smith and J. Smith, Queen-street, Cheapside—Improvements in the manufacture or construction of pocket-books, portfolios, and similar articles
703. W. A. Biddell, Great Sutton-street—Improvements in alarums and signals to be used in or on railways, ships, houses, buildings, plantations, or other places, for the purpose of giving audible or visible signals in cases of danger or alarm
704. G. Beaumont, Halifax, York—Improvements in machinery or apparatus for the manufacture of solid, hollow, and ornamental bricks

*Dated March* 27.

705. A. E. Forty, Kennington, and W. Haynes, New Kent-road—New composition of materials suitable for mouldings, and for most purposes for which leather and gutta-percha have been or may be employed
706. H. A. Archreau, Paris—Improvements in treating powders of charcoal, coke, coal, peat, and generally all matters obtained by the carbonisation of mineral, vegetable, and animal substances, and in applying the said powders to useful purposes
707 A. Prince, Trafalgar-square — Improved method of hardening fatty and oily matters employed in and for the manufacture of candles. (A communication)
708. F. Phillips, Hall Farm, near Brandon, Suffolk—Improvements in machinery or apparatus for cutting, grating, or preparing vegetable substances
709. J. A. Manning, Inner Temple—Improvements in the treatment of sewerage

*Dated March* 28.

711. J. Hipkiss, Birmingham—New or improved dress-fastening
713. H. A. Archereau, Paris—Improvements in galvanic batteries
715. J. Roberts, Bruton-street, Bond-street—Improvements in the construction of cabriolets
717. W. Hähner, Leghorn—Improvements in the manufacture of muriatic and sulphuric acids. (A communication)
719. W. Hähner, Leghorn—Improvements in the manufacture of alkaline sulphites, and in purifying and treating gases. (A communication)

*Dated March* 29.

721. J. H. Johnson, Lincoln's-inn-fields—Improvements in the construction of millwork, and in the mode of driving the same; part of such improvements being applicable for transmitting motive power generally. (A communication from H. F. Negrier, Toulouse, France)
723. R. H. Causton, Battersea—Improvements in the manufacture of mill-bands

*Dated March* 30.

725. J. F. Lucevilliard, Dijon, France—Improvements in fastening or sustaining to the body the various parts or objects of body clothing, equipment, and harnessing
726. W. Corrall, Albert-street, Mile-end—Constructing the several parts of vehicles of hollow metal tubing or pipes
727. W. Johnson, Lincoln's-inn-fields—Improvements in galvanic, electric, and magnetic apparatus. (A communication)
728. W. Tucker, Old Brompton, and W. Adams, Kensington—Preventing the escape of fuliginous smoke from shafts and flues
729. E. Townsend, Massachusetts, U. S.—Improvement in machinery for sewing cloth or other material. (A communication from A. Swingle, Massachusetts)
730. H. Cowley, St. Giles, Oxford—Manufacture of bricks, either solid, moulded, or perforated, by improved machinery
731. J. Sandys, Electric Telegraph Works, Upper Whitecross-street—Improvements in electric telegraph instruments
732. T. R. Crampton, Buckingham-street, Strand—Improvements in crushing, washing, and separating ores and minerals
733. P. J. Passavant and J. Cure, Bradford, York—Improvements in machinery or apparatus for combing wool and other fibrous substances
734. W. Simpson, Birmingham—Improvements in apparatus for communicating alarm-signals on railways
735. H. Y. D. Scott, Queen's-terrace, Woolwich—Improved cement, applicable as a mortar, or for moulding purposes
736. E. C. Willis, Cambridge—Improved mode of manufacturing gutta-percha into sheets
737. A. V. Newton, Chancery-lane—Improved construction of hone. (A communication)

*Dated April* 1.

744. D. Forbes, Edinburgh—Improvements in facilitating a reference to books
746. J. Inshaw and J. Parker, Birmingham—Improvement or improvements in suppressing the smoke and increasing the draught of the furnaces of locomotive and other steam-engine boilers
750. A. V. Newton, Chancery-lane—Improvements in sewing machinery. (A communication)
752. J. H. Johnson, Lincoln's-inn-fields—Improvements in printing fabrics, and in the machinery or apparatus employed therein. (A communication)
754. G. Brocklebank, Point Blackheath, Kent—Improvements in obtaining metals from ores
756. G. F. Wilson, Belmont, Vauxhall, and W. Walls, Glasgow—Improvement in dyeing Turkey red

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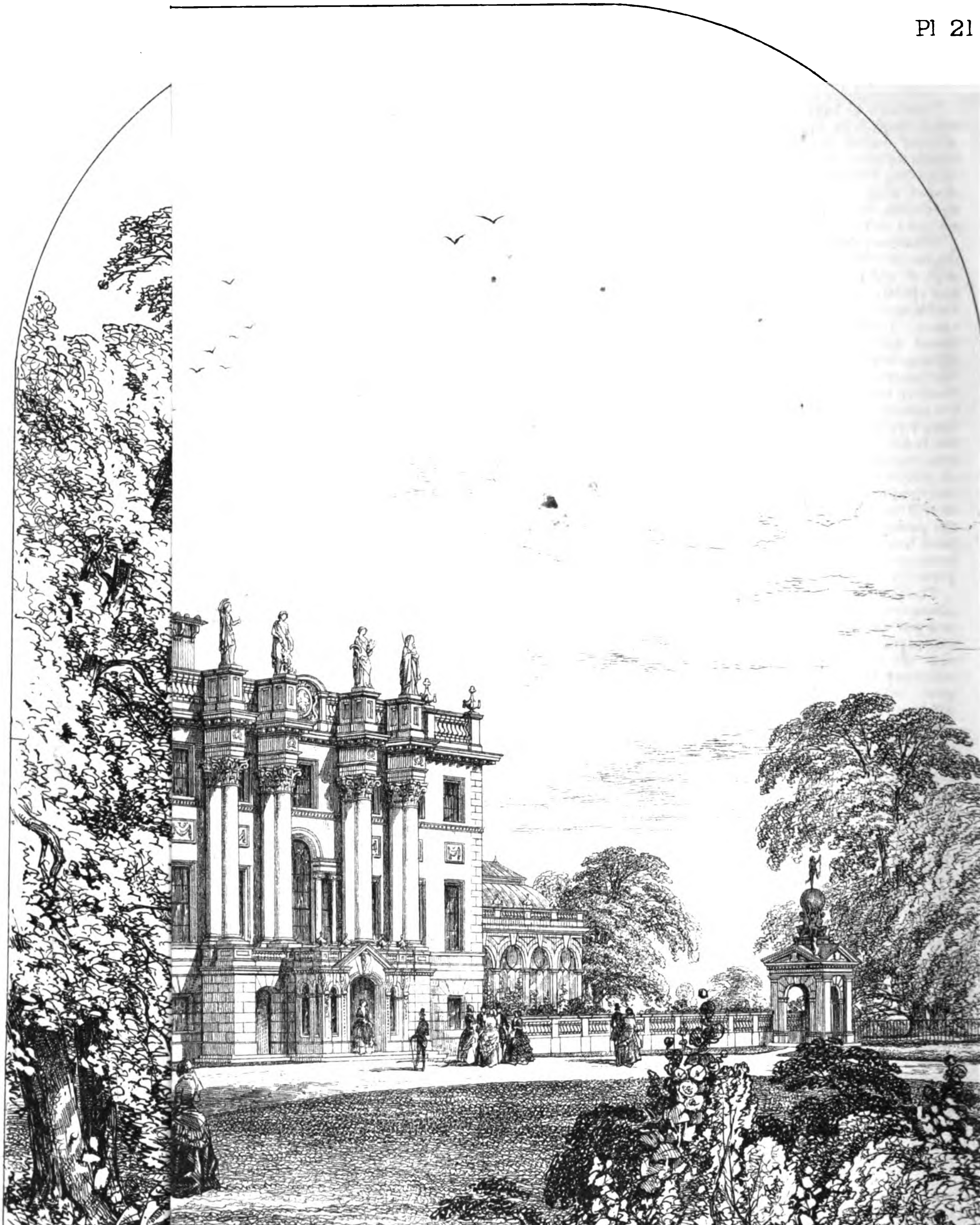
PATENT APPLIED FOR WITH COMPLETE SPECIFICATION.

828. H. Kemp, Creekmoor, Dorset—Improvements in the preparation of wood for planking and sheathing ships and other vessels; also in house, ship, and pier building, railway-sleepers, &c., and all other purposes whatsover where wood is required.—April 8



J. R. Jobbins

R E .

James K. Collins Architect

## HOOTON HALL, CHESHIRE.

(*With an Engraving, Plate* XXI.)

Previous to the alterations, the main portion of the building was a large, bold, square building, of the style practised by the Adams' during the latter part of the last century. It was built wholly of stone, but possessed however scarcely any architectural character, and the offices, including a very fine kitchen and a chapel, were contained in a long, straggling wing building on the north side, adding nothing to the general effect, but appearing almost totally disconnected.

The object sought in the alterations has been to give a greater degree of dignity to the house itself, and to make the offices group with it, and form a consistent portion of the whole, in an artistic and effective manner. The principal additions are—To the main building, a new cornice and balustrade, surmounted by enriched vases. To the entrance front, four detached Corinthian columns, raised upon a rustic basement, and intended to support four figures, each about 8 feet high, representing the four Seasons. In the centre, above the cornice, the crest of the proprietor, R. C. Naylor, Esq., has been sculptured in bold relief, surrounded by his motto, "Hoc age." To the entrance, a commodious porch has been formed, which cannot fail of being a great convenience to the house, for previously there was not the slightest protection from the weather beyond the actual door itself. On the eastern or garden front, a balcony 8 feet wide has been erected, supported on coupled Doric columns, and extending along the whole front. It will be approached through French casement windows, from the centre room upon the principal floor. Rusticated quoins also have been placed at the angles of the building, and a moulding worked round the whole of the windows, which previously were perfectly plain.

The portion of the wing building next the main house has been almost entirely rebuilt, and surmounted with an open balustrade, and pedimented attic windows, forming some excellent servants' bedrooms, stores, &c., which were much wanted. At the angle next the chapel a tower of bold proportions has been erected, about 100 feet in height, having a rusticated basement, a lofty story with Corinthian pilasters at the angles, and an open balustrade with enriched vases, the whole surmounted with an elegantly-proportioned lantern, from which a fine view is obtained of the Mersey and the surrounding country. The lantern is domed and terminated with a copper gilt vane. Within the dome are three bells, and in the principal story of the tower a clock will be fixed, having four faces, which will be made to strike both hours and quarters. One of the rooms in the tower will be fitted up as a smoking-room. The chapel, which previously appeared only as a portion of the offices, now is made to form a distinctive feature in itself, and has received sufficient ecclesiastical character to make its sacred purpose apparent, and yet arranged in harmony with the rest of the building. The windows, which partake somewhat of a Byzantine character, will be filled with stained glass. At the extremity of the chapel is the side porch, which serves both for the chapel and a side entrance to the house.

On the south side of the main building, and attached to it, is the new conservatory, 75 feet in length and 28 feet wide internally. It is formed by an open stone arcade, with enriched spandrils, keystones, balustrade, and cornice. The openings will be filled in with glass in large squares, and the roof will be composed entirely of glass and iron. A communication has been made from the conservatory into the principal drawing-room by an elegant iron staircase; the doors into the drawing-room, and sashes on each side, will be filled with large sheets of plate-glass.

On the garden or eastern side of the house, and around the conservatory, will be formed a beautiful parterre, laid out in elegant designs, and most tastefully arranged with sculpture, vases, &c., by W. A. Nesfield, Esq., who has already been making vast improvements in the park and grounds, and who will probably arrange and greatly improve the drives and approaches to the hall.

The parterre will be inclosed by an open balustrade, and at the south-west angle will be erected an elegant architectural entrance, which will terminate the façade of the western or entrance side of the hall very agreeably. It will be surmounted by a figure of Flora descending to the earth with flowers. The Earth, which will be represented by a large globe, will be supported on the shoulders of three kneeling figures—the whole cast in bronze.

The stone used in the additions and alterations (with some few exceptions) is the same with which the house was originally built — the sandstone from the Stourton-hill Quarries, near Birkenhead.

The architect is Mr. James K. Colling, and the builders Messrs. A. and G. Holme, of Liverpool. There is a drawing of the alterations in the present exhibition of the Royal Academy.

## NEW SMOKE-CONSUMING AND FUEL-SAVING FIREPLACE.

WITH ACCESSARIES ENSURING THE HEALTHFUL WARMING AND VENTILATION OF HOUSES.*

By Neil Arnott, M.D., F.R.S.

[*Paper read at the Society of Arts, London, May* 10*th*.]

The great evils connected with the common coal fires are:—1. Production of Smoke. 2. Waste of Fuel. 3. Defective Warming and Ventilation of Rooms. We shall consider these in order:—

1. *Of Smoke in the Interior of Houses and in the External Atmosphere.*—The proverb which declares a smoky chimney to be one of the greatest troubles of life, may suffice in relation to the interiors; in regard to the exterior, many particulars have to be noted. Examination of the question has ascertained that in London alone, on account of its smoke-loaded atmosphere, the cost of washing the clothes of the inhabitants is greater by two-millions and a half sterling a year (that is, twenty-five times one hundred thousand pounds), than for the same number of families residing in the country; and this is seen to be but a small part of the expense when we consider the rapid destruction of all furniture in houses, as of carpets and curtains, of articles of female apparel, of books and paintings, of the internal decorations, and even of the external surface of the stones of which edifices are built. For personal cleanliness it is necessary to be almost constantly washing the hands and face. Flowering shrubs and many trees cannot live in the London atmosphere, so that the charm of a garden, even at considerable distances from town, has almost ceased with the extension of the buildings and increase of smoke. A growing flower, if exposed to the atmosphere, is always covered with blacks or sooty dust, and defiles the hand which plucks or touches it. Sheep from the country, placed for a few days to graze in any of the parks, have soon a dingy fleece, strikingly apparent when others newly arrived are mixed with them. And this atmosphere, so damaging to inanimate things and to vegetable life, is inimical also to the health of man, as proved by numerous facts recorded in the bills of mortality. Many persons, with certain kinds of chest weakness, cannot live here. Many children brought from the country are soon seen not to be thriving. The coal-smoke, then, may be called the great nuisance and opprobrium of the English capital.

2. *Of Waste of Fuel.*—Count Rumford, a writer of great authority in such matters, after making many elaborate experiments, declared that five-sixths of the whole heat produce in an ordinary English fire goes up the chimney with the smoke, to waste. This estimate is borne out by the facts observed in countries where fuel is scarce and dear, as in parts of continental Europe, where it is burned in close stoves, that prevents the waste. With these a fourth part of what would be consumed in an open fire, suffices to maintain the desired temperature. I have myself made experiments here in London with like results. To save a third part of the coal burned in London alone, would save more than a million sterling a year; and when coal is very dear, as during last winter, the saving would be much greater. Then it is to be considered that coal is a part of our national wealth, of which, whatever is once used can never, like corn or any produce of industry, be renewed or replaced. The coal mines of Britain may truly be regarded as among the most precious possessions of the inhabitants, and without which they could never have attained to the importance in the world which the extraordinary development of their mental and bodily faculties has now given them. It is enough to say that without coal they would not have had or used the steam-engine. To consume coal wastefully or unnecessarily, then, is not merely improvidence, but is a serious crime committed against future generations.

* From the 'Journal of the Society of Arts.'

3. *Of Defective Heating and Ventilating in Dwellings.*—Calling a thousand a week the average rate of mortality in London alone, it was found in the middle of last winter, that nearly 700 additional deaths occurred owing to the intense cold which then prevailed, and against which, evidently, the existing arrangements for warming and ventilating were insufficient. Not a little of the premature mortality at all times, and of the spread of epidemics, and of the low condition of health among the people, is doubtless owing to the same cause.

We shall now inquire whether it be or be not possible in a great measure to avoid the three great evils above described, and at the same time to secure other advantages.

### I.—Smoke.

Is it possible to avoid or to consume smoke—in other words, to produce a smokeless coal fire?

Common coal is known to consist of carbon and bitumen or pitch, of which pitch again the elements are still chiefly carbon and hydrogen, a substance which, when separate, exists as an air or gas. When the coal is heated to about 600° Fah., the bitumen or pitch evaporates as a thick, visible smoke, which, when it afterwards cools, assumes the form of a black dust or flakes, called blacks, or smut, or soot. If that pitch, however, or pitchy vapour, be heated still more, as it is in the red hot iron retorts of a gas work, or in rising through a certain thickness of ignited coal in an ordinary fire, it is in great part resolved into invisible carburetted hydrogen gas, such as we burn in street lamps.

Now when fresh coal is thrown upon the top of a common fire, part of it is soon heated to 600°, and the bitumen of it evaporates as the visible smoke, which immediately rises. Of such matter the great cloud over London consists. If the pitchy vapour, however, be heated to ignition by the contact of a flame or of ignited coal near the surface, it suddenly becomes in great part gas, and itself burns as flame. This is the phenomenon seen in the flickering and burning which takes place on the top of a common fire. But if fresh coal, instead of being placed on the top of a fire, where it unavoidably must emit visible pitchy vapour or smoke, be introduced beneath the burning, red-hot coal, so that its pitch, in rising as vapour, must pass among the parts of the burning mass, it will be partly resolved into the inflammable coal gas, and will itself burn and inflame whatever else it touches. Persons often amuse themselves by pushing a piece of fresh coal in the centre of the fire in this way, and then observing the blaze of the newly formed gas.

Various attempts, beginning perhaps with Dr. Franklin's have been made to feed fires always from below, and so to get rid altogether of smoke. Another more recent one was made about thirty years ago, by an ingenious manufacturer in London, Mr. Cutler. He placed a box filled with coal under the fire with its open mouth occupying the place of the removed bottom bars of the grate, and in the box was a moveable bottom, supporting the coal, by raising which the coal was lifted gradually into the grate to be consumed. The apparatus for lifting however, was complicated, and liable to get out of order, which, with other reasons, caused the stove to be little used. The moveable bottom rested on a cross-bar of iron, which in moving was guided by slits in the side of the coal-box, and was lifted by chains at each end, drawn up by a windlass, and this windlass was turned by bevil wheels, of which one had to be moved by a winch in the hands of an attendant. Mr. Cutler was not aware that others had been engaged in the same pursuit, and took out a patent for his apparatus. A trial at law, however, afterwards decided that he had no patent right.

In the new fire-grate which I am now to describe I have sought in every part the greatest possible simplicity which could give complete efficiency. The combination is represented in the accompanying engraving. The charge of coal for the day is placed in a box immediately beneath the grate, as shown in the diagram at the letters *e, f, g, h*, and is borne upwards, as wanted, by a piston in the box, raised simply by the poker used as a lever, and as readily as the wick of an argand lamp is raised by its screw; the fire is thus under command, as to its intensity, almost as completely as the flame of a lamp. There are notches in the piston-rod for the point of the poker, and a ratchet catch to support the piston when the lever is withdrawn.

The coal-box of an ordinary fire may have a depth of 7 or 8 inches, which will receive from twenty to thirty pounds of coal, according to the area. In winter an inch or two more depth of coal may be placed over the mouth of the box before the fire is lighted, and in warmer weather the box will not require to be quite filled, that is to say, the piston at the time of charging needs not to be lowered quite to the bottom. If it become desirable on any account, as will happen with kitchen fires, to replenish the coal-box in the course of the day; it may be done almost as easily as to put coal on a common fire; thus, when the piston has been fully raised, so as to have its flat surface flush with the bottom bar of the grate *e, f*, a broad flat shovel or spade, of the shape of the bottom of the grate, is pushed in upon the piston, and it becomes at once a temporary bottom to the grate and a lid to the coal-box. The piston being then allowed to sink down to the bottom of the coal-box, the spade or lid is raised in front by its handle, and opens the box, so that a new charge of coal can be shot in. The spade being then withdrawn, the combustion goes on again just as in the morning. That the opening of this lid may be wider, the second bar of the grate is hinged, and yields to the upward pressure of the spade.

This fire is lighted with singular ease and speed. The wood is laid on the upper surface of the fresh coal filling the coal-box, and a thickness of three or four inches of cinder or coked coal left from the fire of the preceding day is placed over it. The wood being then lighted, instantly ignites the cinder above, and at the same time the pitchy vapour from the fresh coal below rises through the wood-flame and cinders, and becomes heated sufficiently to inflame itself, and so to augment the blaze. When the cinder is once fairly ignited, all the bitumen rising through it afterwards becomes gas, and the fire remains quite smokeless ever afterwards. A fire-place supplied with coal from below was used by a distinguished engineer in town for ten years, and the fact that his chimney had not to be swept in the whole of that time, proved that no soot was formed.

In the new grate, because no air is allowed to enter at the bottom of the coal-box—for the piston-rod fits its opening pretty accurately—there is no combustion below, but only between the bars of the grate, where the fuel is completely exposed to air, and near the mouth or top of the coal-box. The unsatisfactory result of some other attempts to make such a fire have been owing, in part, to the combustion extending downwards in the coal-box, because of air having been admitted below, and then consequent melting and coking of the mass of coal, so as to make it swell and stick, impeded the rising of the piston.

A remarkable and most valuable quality of this fire is, its tenacity of life, or its little tendency to go out or be extinguished. Even after nearly all the coal in the grate, surrounded by the fire bars, has been consumed, the air will dive into the coal-box and keep the fire there gently alight, like a torch burning from the top downwards, until nearly the whole contents of the box are consumed, and thus the fire will remain burning for a whole day or night, without stirring or attendance. and yet at any moment it is ready to burn up actively when the piston is raised.

In certain cases, as during long nights, it may be desirable to ensure the maintenance of combustion with rather more activity, and for this purpose there is a slide in a small door at the front bottom of the coal-box, by which a graduated admission of air may be allowed. That door itself is open before lighting the fire, to allow of the removal of any coal-dust or ash which has fallen down past the edge of the piston.

Before lighting the fire in the morning, the little ash which remains with this form of combustion is removed from off the piston. The fire is extinguished at night by allowing it to exhaust itself, or by lifting out the few lumps of coke or caked coal which remain. The morning charge should be such that enough cinder or coke may be left for the smokeless lighting of the next day.

By the means now described, then, the first-named evil of the production of smoke is effectually combatted.

### II.—Waste of Fuel.

We now come to consider whether the *waste of fuel* which occurs in common open fires can be prevented.

Count Rumford, as the result of his own experiments already referred to, declared that five-sixths of all the heat produced in a common open fire passed up the chimney with the smoke, and therefore to waste; and he appealed in corroboration to the experience of the continent of Europe, where close stoves are used, which do not thus waste heat up the chimney, and where a much smaller allowance of fuel than is here needed in open fires suffices. I have, in my own house, a striking illustration of the matter in a peculiar enclosed fire, which, for fourteen years past, in a large dining-room, has maintained, day and night, from October to May, a temperature of 60° or more, accompanied with good ventilation, by an expenditure of only 12 lb. of coal for 24 hours, or about a fourth of what would be used in an open fire burning for 15 or 16 hours. This fire is lighted about the beginning of October, and is not extinguished until the following May. The aperture by which the fresh air enters the stove to maintain the combustion sufficient to warm that room, is about ⅞-inch in diameter. If this be compared with the aperture of a common chimney-pot, which has a diameter of 10 inches and an area or size 150 times greater than my stove, and one thinks of the rapidity with which a column of dense smoke filling that pot escapes from it when the fire is burning briskly; and reflects further that such column consists entirely of the warmest air from the room, blackened by a little pitchy vapour from the fire, there is proof of prodigious waste, and room for reasonable hope that a saving is possible. To see how a saving may be effected, the exact nature of the waste in such cases has now to be explained:—A single mouthful of tobacco smoke, on issuing, immediately diffuses itself so as to form a cloud larger than the smoker's head, and soon would contaminate the whole air of a room, as would also the smoke and smell of wood, paper or other combustible burned in a room. Now, the true smoke of a common fire is not the whole of what is seen issuing from the chimney top, but only little driblets or jets which shoot up or issue from the cracks in the upper surface of coal which forms the fire. These jets, however, quickly diffuse themselves, like the tobacco smoke, in the air around them, that is to say, in the large volume which fills the space left over a common fire, and over the hobs, if there be such, at the side of the grate. The whole of the air so contaminated, and which may be in volume 30, 50, or 100 times greater than that of the true smoke, is then all called smoke, and must all be allowed to ascend away from the room. It is evident, then, that if a cover or hood be placed over a fire, such as is represented by the letters *y*, *a*, *b*, in the diagram, so as to prevent the diffusion of the true smoke or the entrance of pure air from around to mix with it, except just what is necessary to burn the inflammable gases which rise with the true smoke, there would be a great economy. This has been done in the new fire-place, with a saving of from one-third to one-half of the fuel required to maintain a desired temperature. In a room the three dimensions of which are 15 feet, 13½ feet, and 12 feet, with two large windows, the coal burned to maintain a temperature of 55° in the coldest winter days, has been 18 lb. for 19 hours, or less than a pound per hour.

And it is to be remarked that not nearly the whole possible saving has been effected in the case referred to; for the grate was an old one imperfectly altered, and as the true smoke, little diluted, is very hot air when it leaves the ignited coal, and if it were made to pass, in contact with a vessel containing water or colder air, it would give up for use a considerable part of its heat. In many cases such saving will be profitably effected. Under the present imperfect forms of open fire, the whole of the hot smoke passes away as certainly as here, but at present is so much diluted with the colder air of the room, that ordinary observers do not perceive, and, consequently, do not regret, the fact.

In many cases the contraction of the space over the fire will be more conveniently made in brickwork than by a metallic hood. Where the hood is used, unless it be made a boiler or water-vessel, it should be lined with tile to prevent that overheating which would cause in the room some smell of heated metal.

The stalk of the hood at *y*, passes closely through a plate or other stopping at the bottom of the chimney, so that no air shall enter the chimney but through the hood; and there is a throttle-valve or damper in the hood-stalk, at *t*, giving a perfect control over the current of air that passes through. No part of the apparatus is more important than this valve or damper, and its handle or index must be very conspicuous, and have degrees of opening marked on its plate as clearly as the points are marked on a compass-card. When the valve is quite open, the chimney acts to quicken the combustion like that of a blast-furnace, or like a forge-bellows; but, by partially closing the valve, the current may be diminished, until only the most tranquil action remains. The valve should not be open in general more than just enough to let all the burned air or thin smoke, which is scarcely visible, pass through. When the valve is once adjusted to the usual strength of chimney action, it requires little change afterwards.

In many cases it is desirable to be able to command and modify by a moveable plate, the size of the front opening of the hood or fire-place, as well as the opening of the chimney throat. By the proper adjustment of the two, the desirable brightness of the front of the fire may be maintained.

The chimney-flue above the upper opening of the hood should have its sides made slanting, so as not to harbour dust or any soot which, from any careless use of the fire, might be produced. The size of the chimney-flue is not important.

The answer then to the second question, as to the possibility of saving fuel, is by the facts here adduced, given in the affirmative.

### III.—Defects of Heating and Ventilating.

The third and last of the great evils of the present open fires is that there are great irregularities and deficiencies in their heating and ventilating actions, which bear so powerfully on the public health. The hood and its damper, as influencing these, may appear perhaps of more importance than as saving the fuel.

The hood and its damper, by allowing so small a quantity of air to pass through in comparison with what rises in an open ordinary chimney, lessens in the same degree the cold draught of air towards the fire from doors and windows, and which are to the inmates common causes of winter inflammation and other diseases; and for the same reason the heat, once radiated from the fire towards the walls of the room, not being again quickly absorbed and carried away by such currents of cold air as are referred to, remains in the room, and soon renders the temperature of the whole more equable and safe.

Still more completely to prevent cold draughts approaching from behind persons sitting around the fire, the fresh air for the room is conveniently admitted, chiefly by a channel which leads directly from the external air under the floor to the hearth, and there allows the air to spread from under the fender. The fender, exposed to the fire near it, becomes hot; the cold, fresh air then rising under it takes from it the excess of its heat and so becomes itself tempered before it spreads in the room. The two evils of excess of heat and excess of cold, meet to neutralise each other, and to produce a good result.

The importance of general ventilation, again, is strikingly exhibited by such occurrences as the following, which was related at the meeting of scientific friends at which I first described the new fire-place, by Mr. R. Chambers, of Edinburgh, as having happened not long ago in Glasgow. A large old building, which had been formerly a cotton-mill, was fitted up as a barrack or dwellinghouse for persons of the working classes, and had nearly 500 inmates. Like all foul and crowded human dwellings, fevers and kindred diseases soon became prevalent there. After a time a medical man who was interested obtained permission from the proprietors of the neighbouring chemical works, in which there was a lofty and very powerful chimney, to make an opening of 1 foot in diameter into the side of the chimney for the ventilation of the lodging-house. He then connected with this a main tube from the lodging-house, which had branches running along all the passages or galleries, and from the ceiling of every separate room a small tube communicated with these branches. Soon after, to the surprise as well as to the delight of all concerned, severe diseases entirely disappeared from the house and never returned.

Now the chimney of the new fire-place, although not very tall, has a ventilating power scarcely inferior to that of the Glasgow chemical works. The arrangement of the hood with its valve, as above described, by allowing only unmixed and very hot smoke to enter the chimney, instead of, as in common chimneys, smoke diluted with many times its volume of colder air, increases the draught just as it does the heat of the chimney, and through an opening then made into the chimney from near the top of a room, all the hot, foul air in the room, consisting, perhaps, of the breath of inmates, smell of meals, burnt air from candles, lamps, &c., and which else accumulates and stagnates at first near the top of the room, is immediately forced into the chimney and away. This is strikingly proved by placing near the ventilating opening a light body, as feathers or shreds of paper suspended to a thread, and seeing with what force it is drawn into the opening.

In the diagram the opening is represented at the letter *v*, having the common balanced chimney-valve in it, which, by the wire descending to a screw within reach of the hand, can be left open to any desired degree.

That valve I recommended many years ago, and its use has become pretty general over the country, but, in many cases, what I described as an essential concomitant—the contraction of the chimney-throat and the space over the fire—has been omitted, and the proper action of the valve has been prevented.

This is what I had to say on the correction of the third of the great evils of the common fire, and I hope it has been shown to be possible to construct an open fire-place, scarcely differing in appearance from an ordinary English fire-place, with its pleasing associations, but which shall be smokeless, saving much fuel, and ensuring the healthful warmth and ventilation of our houses.

There are yet subordinate advantages of the new arrangement of fire-place, among which the following may be noted.

1. Chimney-sweeping can scarcely be wanted where there is no soot.

2. Chimney-flues without soot cannot catch fire, and, if fire were in any way there introduced, by shutting the hood valve it would be certainly extinguished. Thus a large proportion of the conflagrations of buildings may be avoided.

3. The huge evil (almost universal) of smoky chimneys cannot occur with this grate.

4. The occasional sudden rush of air towards a hot wide chimney, when the door is opened, and which carries readily the light muslin dress of a lady towards the grate and inflames it, cannot happen with this grate.

5. The danger of sparks from exploded pieces of coal thrown on the carpet does not exist here, for all the coal is first heated and coked while deep in the coal-box, and covered over. Thus a fire-guard is not wanted on this account.

6. The strong draught of a voracious fire in one room, or in the kitchen of a house, cannot disturb and overcome the action of other chimneys in the house, as is now very common.

7. The strong draught of any well-constructed fire-place may, by a connecting tube be made to ventilate any distant rooms, staircases, cellars, closets, &c.

8. The strong and copious draught caused by momentarily opening the hood valve or damper will prevent the diffusion of dust when the fire is stirred or disturbed.

9. The chimney-valve, by its powerful ventilating effect, obviates all objections to the use of gas-lights in houses, thus leaving the beauty, cleanliness, cheapness, and many conveniences of gas unmarred. Explosion from accidental escape of gas in a room or house, of which occurrence there have been some destructive instances, cannot happen where there is the ventilating chimney valve, for cold coal-gas entering a chimney-flue produces a more powerful draught than hot air does.

10. The improved chimney draught in attic or upper rooms will make these more valuable, and will increase the comfort of low houses and cottages.

11. It would, moreover, be convenient occasionally to carry the flue of a close stove, or bath, or the ventilating tube from lamps in staircases, into any acting chimney.

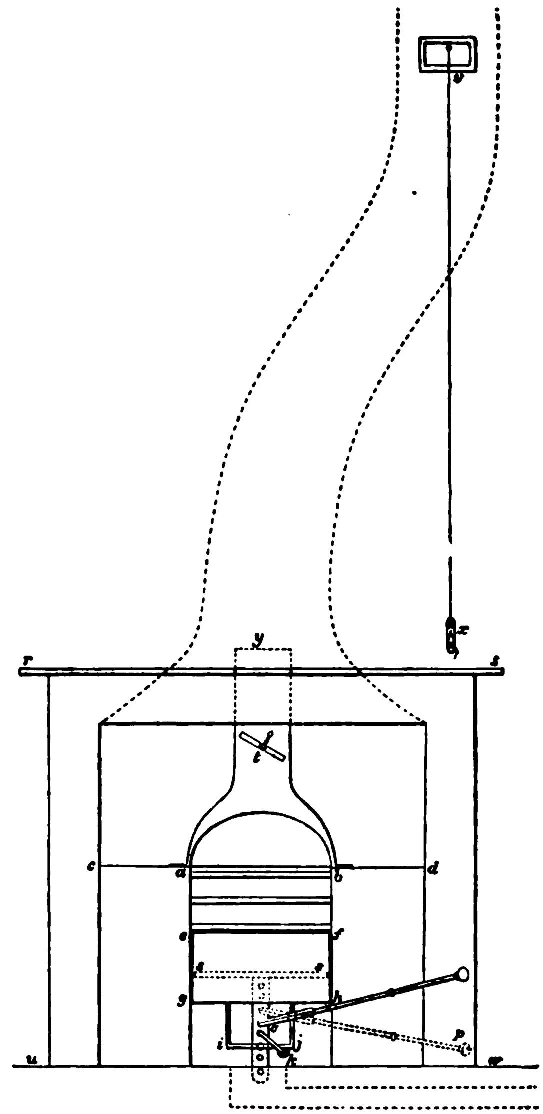
12. This torch-fire (as some have called it, because it burns from above downwards, like a torch or candle) is remarkably adapted also for the purpose of the kitchen.

13. The change of any existing grate of an old fashion into this is easy and inexpensive, and by having a piston-plate with holes it can be used as a common grate.

14. Any kind of coal or coke may be used in this grate, even the small culm or coal-dust, which is very cheap. In a common grate, coke or Welsh stone coal would be objectionable, because containing chiefly heavy carbonic acid instead of the steam and carburetted hydrogen of bituminous coal, and the gas, which is poisonous, might spread in the room, but by the strong draught of the hood this could not happen.

I might extend this list, but I need not.

Before concluding I may direct attention to the remarkable fact, only of late well understood, that of the only four great necessaries of life, or things which Providence has left to man in various parts of earth to procure for himself, namely, fit air, temperature, aliment, and work alternating with rest,—the skilful management of a domestic fire goes far to secure the two first-named, viz., fit air and warmth; but these are the last which men come to understand well, because they are invisible and impalpable, and, therefore, to be perceived only by the eye of the mind after much cultivation.



The diagram represents a common fire-place with mantel *r s* or chimney piece, two jambs, and a common grate with two bars and bottom, to which four parts, the essentials of the new fire-place, are added. *e f g h*, is a box or receptacle of iron to contain the charge of coal for the day, with its open mouth placed where the bottom bars of the grate had been. It may stand on feet on the hearth, or may be fixed to the grate. Besides its fixed bottom *g h*, it has also a moveable bottom *s s*, like a piston, on which the coal immediately rests, and is lifted as wanted, or let down as the piston moves; a piston-rod passes through the fixed bottom, steadied by a guide-hole in the stirrup or bar *i j*, below. The piston-rod has notches or openings in it to receive the points of the poker *p o*, which, acting as a lever, having its fulcrum in the foot of the box or otherwise, lifts the piston. A catch or pall *k*, falls into the notches as the piston rises, to prevent its return until desired. In the centre of the bottom front is a door which is opened at will to admit a little air if wanted, or for removing small coal or ashes which fall past the piston. Where the grate is set low a small opening is made in the hearth to allow the end of the piston to descend.

*a b y*, is a hood or cover for the fire, like an inverted funnel opened in front, placed over the fire to contract the open space there, and to receive the true smoke of the fire and convey it little diluted into the chimney-flue at *y*. *t*, is a valve or damper, placed in the narrow part of the stalk of the hood to give complete control of the current of air passing through. There is an index externally, showing clearly always the position of the valve. *y v*, marks the direction of the chimney-flue in the wall, having generally to bend to one side to avoid the fire-place of the room immediately above. *v*, is the ventilating chimney-valve, admitting air from near the top of the room to the flue, balanced nearly on its centre of gravity so that the least pressure from without opens it inwards, but any pressure from within, as of smoke, closes it. There is a wire descending from the valve, with a screw or loop-peg, for partially or wholly closing it. There is a channel underneath the hearth by which fresh air, directly from the atmosphere, enters the room, to be warmed under the fender or near the fire, and then to spread in the room. It has a controlling-valve.

## ON THE DRAINAGE OF BUILDINGS AND STREETS IN THE METROPOLIS.

A discussion took place at the Royal Institute of British Architects, upon the paper read by Mr. Boulnois, on the above subject (*ante* p. 181), commenced by the Chairman (Mr. Mocatta), who congratulated the meeting on the very able manner in which a subject of vital importance to the health of the metropolis had been brought forward, and hoped that its discussion might elicit valuable opinions to assist in the adoption of a perfect system of drainage throughout the country. Considering that this great question had been much discussed, and that more experiments had been made in this than in any other country, it was most extraordinary that they had not hitherto been able to arrive at any correct conclusion on the subject.

Mr. Garling said, that he was much gratified to learn that Mr. Boulnois had a decided objection to the use of pipes for sewers, and also to small sewers generally. Indeed, he considered pipe *sewers* to be both defective and unscientific for the metropolis or for any large town, as the sewers for such places ought to be large enough to enable workmen to enter, and examine and cleanse them. A 12-inch pipe sewer had been lately made in Hatton-garden about 1000 feet long, intended for the drainage of the houses, as well as for the surface. This size he considered vastly too small, even to carry off the water from the area it was constructed to drain. For in a thunder storm, such as sometimes occurred, and which, therefore, ought to be provided for, sufficient water might fall in one hour to fill such an aperture completely full for a length upwards of three miles long, or about some sixteen times its extent, so that in the event of a stoppoge, or the water not running off with sufficient velocity, the consequences might be most serious; and, indeed, there were now repeated complaints of its being the cause of stoppages and overflows in the street in heavy rains, though with very little more than the surface water from the street at present running into it. With reference to this pipe sewer, Mr. Garling afterwards observed, that in order to aid its current, it was laid with a fall of 1¼-inch in 10 feet, or equal to 55 feet in a mile, a fall so utterly impracticable on a large scale, that supposing a sewer with such a current to be laid down in Oxford-street (which was about 1¼ mile long) and with a water bed 12 feet deep below the surface of the street at one end, it would be 60 feet above that surface, or as high as the roofs of the highest houses at the other end. The liability to fracture of pipes used as *sewers* was another objection to the system for the drainage of any large city, from the difficulty of ascertaining the exact place of the defect. The drainage of houses by pipes, assuming a separate drain to each, was less objectionable; but even in house drains a pipe, 6 inches bore, was not ordinarily large enough. He thought there could be no doubt that small drains became stopped up much more frequently than large ones; and he believed that the water ordinary flowing in from closets and sinks was not sufficient to cleanse the small drains commonly used. He knew an instance of a small drain, only 10 feet long, which was connected with a 4½ inch soldered soil and rain-water pipe, being choked up for some months, notwithstanding there was a head of water standing 45 feet high in the pipe, and when the drain was opened, the water flowed from the opening like a fountain, spouting up seven or eight feet, and yet it had not been able to force its passage through this short length of small drain. Again, there was an absolute necessity for the admission of air into drains, or the water would not flow; this may be an air vent having communication with the external air as high up as possible to avoid smell, or else with the sewer, which latter some might think strange. A very frequent cause of drains being stopped was their being "air-bound," as it was termed; and another evil resulting from this was, that if the air was not allowed to flow into, and escape from the drains by some other way, the water would be drawn out, or forced out of the air traps, as the case might be, and a stench would arise in consequence. If a drain was not as hermetically sealed as it could be by art, except the necessary vents just named, it would always smell; and a frequent defect causing this was the imperfect connection of the soil and rain water pipes with the drain. These pipes should always have proper flanges at the junction bedded in brickwork in cement. One objection to pipe drains was, that in case of a defect it was difficult to discover its exact position without breaking up, perhaps, the entire drain, or great part of it; and therefore a cemented brick drain, or a drain covered with slate or stone, was preferable in that respect; and this remark of course applied equally to pipe *sewers*. With regard to back drainage he quite agreed with the arguments urged by Mr. Boulnois; and a further objection was to be found in the fact that what was an area or a back garden at present might hereafter, and perhaps very soon, be built upon, and converted into a house or warehouse; and, therefore, a drain properly placed there as an external drain at one time, would afterwards become an internal one. Experience had amply shown the force of this remark, not only in the city, and in places like Oxford-street and Piccadilly, where scarcely a back yard was left, but in the suburbs. Moreover, in back drainage, which was not separate drainage of each house, there would also be a difficulty arising from the opposing interest of the different occupiers, who would constantly object to having the drains in their premises opened to discover defects, from which perhaps their neighbours, and not themselves, might be sufferers. The drainage of every house should be distinct from that of the neighbouring houses—there should be no drain runnning from one house under the others—in which case the basement at the lowest level might suffer from the defect in the drain of the higher one. A case came to his knowledge in Spencer-street, where a house became almost uninhabitable from the stoppage of the drain in other property which it ran through at the back, and the occupant had made repeated efforts to get it opened, but without success. His appeal to the ground landlord's agent was in vain; neither the parish authorities, nor the Commissioners of Sewers, he was told, could give him any relief; and he at last found that his only resource would be to apply to the Court of Chancery. Cases of this kind would constantly occur under the back drainage system, and an immense amount of litigation and inconvenience would ensue. Nearly thirty years ago he had himself advocated in a public journal many parts of the system recently proposed. He had then declared that no sewerage whatever ought to go into the Thames at any place above Grays; that on the North side of the river there should be a main sewer—say from Chelsea to Grays Reach; that at or about Chelsea there should be large tidal reservoirs to be filled at high water, and at about two-thirds ebb this water should be used occasionally for the purpose of flushing the sewers; and that two large reservoirs should be formed at Grays apart from all dwelling-houses, where the sewerage should be alternately first in one and then in the other, decomposed by chemical means, and removed in barges. Mr. Garling concluded by repeating his objection to pipe sewers and small drains of all sorts. As a general rule he scarcely knew a small drain that did not choke up, nor a large one that did.

Mr. Haywood, C.E., with reference first to the question of main sewers, stated that he was not a thoroughgoing advocate for brick sewers alone, having himself used and intending still to use pipes; but he did so only to the extent to which, in his opinion, pipes might properly be applied, and not to the extent of the telescopic system as it might be termed. And in this he differed with many advocates of the tubular system. He considered that every town should be judged of by its own conditions and that the main streets of all towns of ordinary size should' have sewers large enough for men to enter, the minor streets being left to the judgment of the engineer. It was necessary that sewers, or ducts of some kind, should be provided for carrying off rain water or storm water, house drainage and subsoil drainage: the latter was a most important point, because a dry basement was a most invaluable advantage; and it was almost as important that a house should be dry, as that it should be free from smells. The question of the best mode of accomplishing all the desired objects was in reality how this could be most economically performed, for it might be done in two or three ways.

Some persons advocated three sets of sewers for this purpose. He thought, however, that as a new theory could not be tested for many years, until it was so, a brick sewer, large enough for men to enter, which had been found to answer all the purposes, as being the most simple, was the best. He was convinced that a brick sewer would be found to answer every purpose that could be effected by two or three sets of pipes. Sewers ought to be monumental in their character, and if constructed in our day, none of us ought to except to see them replaced by new ones. They ought, indeed, at least, to last for a century, and the sewer in the main street of a town ought never to be broken up till it was worn out. A sewer, whether of brick or pipe, so small that a man could not enter it, should never be employed in such a street. That brick sewers would drain the subsoil effectually might be illustrated by the fact that throughout the city generally they had been able to lower the surface of water in the gravel as much as six or eight feet; and the basements of many houses, which twenty-five years ago had been almost useless, were now available for the stowage of the most costly materials, such as silks and other goods, and numerous other purposes. He believed the rateable value of the property thus gained was not less than from 20,000*l.* to 30,000*l.* a year. He had now a great number of sewers which had not been opened for years, and which, he believed, never would need to be opened again. With regard to stoppages in pipe sewers, it was stated by their advocates, that it was very easy to obviate them, as they were always found to be preventible stoppages, but where stoppages occurred repeatedly from similar causes they could not be called preventible, but rather constant and unpreventible stoppages, and to that every sewer was subject. Within the last few days one of his pipes had been stopped from end to end. He had built about 120 or 130 pipe sewers, and having used extreme care in their construction he had only had one breakage. With regard to the breakage of pipes, of course that could be obviated, as it would be very easy to make pipes strong enough for all purposes, and the breakage of pipes could not be well alleged as a reason for not using them. He had had two or three trifling stoppages in his pipe sewers, and recently there had been one of a serious nature in Leadenhall Market, a place, the surface of which, of course, could not be broken up with impunity, or without causing great inconvenience. The houses draining into that pipe sewer were occupied by respectable tradesmen, to whom money was not an object, and every appliance had been used in the houses to make both drains and sewer self-acting. The pipe, however, was stopped from end to end, and he could not tell the cause of it, nor whether that cause was preventible or not. He had opened the sewer in three places in a length of 135 feet, but had not broken the pipes. It was doubtful whether that sewer could ever be restored to its integrity again. Referring to one of Mr. Boulnois' diagrams he stated, that when a soft bed of deposited matter once accumulated in a sewer, it became a nucleus which impeded everything passing through it. If he might be permitted to allude to published books, he would refer to a blue-book which contained a diagram of the sewer in Holborn, which was within his jurisdiction. In the first place the sewer in this diagram was placed upside down; and further it appeared that a diagram similar to Mr. Boulnois' was shown to a witness, who was asked two or three extraordinary leading questions, with a view to show that the brick sewer in Holborn was five or six times the necessary size, because a pipe of the size shown would carry off all the water of Holborn; but the party had forgotten, or probably did not know, that it was intended to carry off not only the Holborn water and foul matter, but that of a large area adjacent. There was a curious general advocacy of the tubular system in this blue book, with a vast amount of theorising on this subject, which, if it proved anything, would prove that a 2-inch pipe was large enough for any house of a moderate size. The size, however, of a drain must be determined by practice, and when the advocates of the very minute system of drains objected that drains, as generally constructed, were double or treble the necessary area required, he (Mr. Haywood) would only reply that, even in determining the sizes of their own drains, they had exceeded the size which their theory pretended to show was sufficient, and they did so because they said that practically it was necessary to have larger than that given by theory, which he quite agreed with, and would state, that according to his *practice* a 3-inch drain was not large enough for a house. Ventilation of sewers was absolutely necessary, otherwise they would ventilate themselves into the houses. The plan of ventilating into the centre of the street, although a bad one, was perhaps the best that could be adopted at present, as it brought the stream of foul air where it could be the easiest diluted and carried off. With regard to ventilating by the rain-water pipes he had found it to answer, although many complaints were made of smell being perceptible in the houses through such mode of ventilation; where the foul air had been conveyed above the chimney-stacks, it appeared in certain conditions of the atmosphere that the effluvium descended again. It was rather a medical question whether it would be better to ventilate in the centre of the street or by the peoples' dwellings, but for himself he was in favour of employing flues; and he thought that a compulsory measure (such as appeared to be getting fashionable) to make manufacturers allow the use of their flues and tall chimneys for the purpose of ventilating the sewers, might be introduced with advantage,—but he would say nothing as to the justice of such a measure. With regard to the drain pipes of Rome and Pompeii he imagined that the Romans collected and applied their fæcal matter to agricultural purposes, as was now done on the continent generally, and that the pipes, of which a specimen was on the table, only carried off the superfluous water of the house. At present one of the great difficulties in Paris was the increasing habit of using water-closets, which had greatly diminished the value of manure, which had brought them hitherto a rental of about 30,000*l.* a-year; and although they abused the Londoners for polluting their river, one of the engineers of Paris had told him (Mr. Haywood) that he was much afraid they would be compelled to do the same, unless the usage of water was restricted. Whatever sized pipes the Romans used to carry off water, it was certain that they used large and flat-bottomed sewers, and the charge of those sewers was deemed a highly important office, as he hoped it would also become in this country. Back drainage in this metropolis, he considered, would be fraught with the greatest inconvenience. Where two, three, or four waterclosets were close together, one drain might be employed, but to carry the drain through the property of many different occupiers would be a most serious disadvantage. Without interdicting this system in all cases he thought it wrong to lay it down as a general principle, and he quite concurred in the opinions stated by Mr. Garling on this point. The public not seeing the objections to this plan might be carried away by its first cheapness, but the ultimate inconvenience of it would be very great.

The debate on this subject was continued on April 3rd, Mr. W. S. Inman in the chair, when a communicatisn was read from Mr. S. Morris, in which the writer adverted to a suggestion made by himself some years ago to the Commissioners of Sewers, for obviating the inconvenience attendant upon syphon sewers during high tides, whenever the quantity of rain falling exceeds the capacity of the sewers, which are then resolved into reservoirs, and having no exit at the flood-gates, cause an overflow in the localities in which they are situated. Mr. Morris proposes that the water be allowed to find its way to a suitable level by the simple law of gravitation, where pipes should be provided for its further progress, similar to those employed by the water companies, which, within certain well-known limits, would allow of such undulations as the intervening surface might require. Thus a reservoir at Piccadilly might have its eduction-pipe carried below the level of St. James's-park and the lowest parts of Westminster, and raised up over the embankment of the river, so as to pour a continuous current into the Thames at all states of the tide. Intercepting sewers of very considerable length would by this be wholly obviated, and the enormous expense of construction avoided. The pipes, it may be mentioned, would not exhaust themselves, but act on the principle of intermitting syphons.

Mr. Bazalgette, among other observations, corrected an inaccurate statement in an article in the *Builder*, headed 'Progress of the Manufacture of Tubular Drain Pipes,' which stated, that "it is estimated that in the metropolis about 15,000 houses have been drained with 4-inch tubular drains, and about half as many with 6-inch drains, while upwards of 250 miles of pipe-sewers have been laid in streets;" whereas the total number of houses drained within the last four years amounted to 26,978, of which 4926 were drained in 1850; 8581 in 1851; 6271 in 1852; and 7200 in 1853. Of this number, 20,000 (instead of 7500, as stated in the *Builder*) were drained with 6-inch pipes. Mr. Bazalgette further remarked, that although the numbers had been erroneously stated, it was true that 4-inch pipes had been largely used, but it was equally true that they *had failed* to a great extent, and caused a considerable amount of inconvenience. The present Commissioners of Sewers were often called upon to take up 4-inch and lay down 6-inch pipes, and although they did not feel justified in spending the public money in that way, it was being done to a great extent by private individuals. In the same manner, the quantity of pipe sewers ("upwards of 250 miles") have been greatly overstated in the article referred to. They had however been extensively employed, and, as the diagrams of Mr. Boulnois proved, they had often been incautiously applied. Without entering upon a crusade against pipe sewers, he would state what the Commissioners of Sewers, with his entire concurrence and recommendation, were now doing. During the last year, they executed about 22 miles of public brick sewers and 6 miles of pipe sewers, whilst private individuals had executed about 12 miles of brick sewers, and about 85 miles of pipe sewers and drains; making a total of nearly 35 miles of brick sewers, and nearly 92 miles of pipe sewers and drains. This statement would show that the Commissioners did not advocate any exclusive system, but that under certain circumstances and for minor branch sewers they considered pipe sewers advantageous. The old practice of brick sewers led to a large expenditure, but did not end in failures nor produce disease, whereas if the use of the modern pipe was carried beyond its proper limits, failures and obstructions occurred, together with an amount of injury to the public health which could not be estimated by pounds, shillings, and pence. Some of the new theorists on drainage announced their systems as the most "economical and efficient," but "the cheapest and best house in London" was generally neither the cheapest nor the best, and a system of drainage which might be most expensive in the first instance might be the cheapest in the end. It had been strongly asserted, that pipes or small sewers were self-cleansing, whereas large or brick sewers had a sluggish flow, and became in fact merely elongated cesspools. He could state most positively from experience, that this was not the case. It was true that some of the large sewers in London were not self-cleansing, but this was because they were situated in low and flat districts, with their outlets pent up for eight hours at a time by the tide; but from their size they were easily entered and cleansed by workmen, and certainly pipe sewers in the same situations would allow deposit to be made in the same ratio. In fact, taking the best and most modern forms of brick and pipe sewers of the last ten years, and laying them side by side with a tolerable fall under exactly the same circumstances, he could assert that the self-cleansing powers of both would be equal. The representations in blue-books of brick sewers half filled with deposit, were drawn from old sewers without sufficient water flowing through them, many of them now abandoned, and were not fair representations of the existing state of the London sewers. Mr. Bazalgette proceeded to show, by reference to the diagrams, that the proportion of the sectional area of the sewage water to the frictional surface of the sewer or drain over which it flowed, in conjunction with the fall, governed the self-cleansing power, and that egg-shaped brick sewers of proper dimensions had the advantage over small pipe sewers in this respect, especially in the event of overcharge from storm-waters, whilst they also enabled men to remove the heavy road-drift which was so likely to produce stoppages in the latter. All sewers became in time covered internally with a slimy surface, which produced an equality of smoothness between bricks and pipes, and in execution the bottom of a brick sewer could be made more uniformly smooth, and consequently less likely to create an obstruction than a pipe with numerous joints. Comparing 4-inch with 6-inch pipes, Mr. Bazalgette applied the theory of the proportion of area to frictional surface, and contended that the scouring power in the former, when three-parts full, would be practically the same as in the latter when half-full, and that the 6-inch pipe had an advantage in allowing small substances to pass, which in the smaller pipes would remain, and become the nucleus of an obstruction. With reference, also, to the use of small pipes, it was obvious that a larger pipe would allow for a greater amount of sinking in the ground on which it was laid than a smaller pipe. Pipe sewers should therefore be laid larger than the *theoretic* size, to allow for casualties and defects. On the subject of combined back drainage, Mr. Bazalgette admitted that there were circumstances in which it might be economical and advantageous, but as a general rule applied to London, it would be neither the cheapest nor the best system. The experiments and formulæ of the great philosophers who had studied this subject could not be disregarded, and it was evident from these that a torrent of rain or storm water could not pass through a 6, 9, or 12 inch pipe from a large area. One of the diagrams before the meeting represented the Fleet Sewer, with a sketch of a locomotive engine within it, as a scale to show its immense size, but he (Mr. Bazalgette) knew that on one occasion a few years ago even that sewer was not large enough to carry off the flood water from Hampstead, &c. Whether separate or combined house drainage were adopted, a sewer in the middle of the street for the surface drainage was essential in all large towns, whatever might suffice for mere country roads; and this point, though it materially affected the question of economy, had been overlooked by the advocates of back drainage. Mr. Bazalgette produced a drawing in illustration of the comparison between separate and combined house drainage, and contended, that, both for economy and efficiency, the former system was the better one. In the separate drainage system, each house drain could be probed from the common sewer, without interfering with the adjoining houses in any respect. He further adverted to the difficulty arising from the conflicting interests of different owners, which would prevent the removal of obstructions without the exercise of the legal powers vested in the Commissioners, and likewise referred to the frequent erection of workshops or warehouses in the rear of houses, which would render back drainage further objectionable. Upon the whole, except in poor outlying districts, where as a matter of economy, or to get rid of the greater nuisance of a cesspool, combined drainage might be introduced, the separate system was the best. He considered that in the case of valuable property, where stoppages in the streets and injury to trade was of the most serious consequence, it was essential to adopt large sewers and the separate system, as that which would interfere the least with the trade and traffic. Mr. Boulnois had dwelt upon the breaking of pipe sewers, but he (Mr. Bazalgette) was of opinion that the manufacture of pipes had been greatly improved, and that they might be made strong enough to bear any amount of pressure; although of course the cost was increased by the additional thickness. He considered the half-socket as the best kind of joint. As to the ventilation of sewers, he found that pipes from them carried above the roofs of houses were liable to the escape of effluvium by leakage, or that the smell was brought down to the windows by eddy currents in certain states of the atmosphere. He believed that a system of ventilation by furnaces, as adopted in mines, would be the best plan; but that in the meantime the present system of ventilation, through gratings into the middle of the street, was the best plan that had been practised. He could not approve of Mr. Boulnois' suggestion of a channel for the surface water beneath the foot-pavement, used in the Corso at Rome, inasmuch as straw and dirt would be washed into it, producing floodings, and causing much trouble and inconvenience.

Mr. Burnell, C.E., referred to the plan called "en encorbellement," formerly adopted in Paris, of using a small channel worked in the granite kerb and under the pavement to carry off the surface water. It had been there found, however, that horses were very liable to slip and break their legs in consequence of these gutters, and the use of them was therefore generally discontinued. The Romans confined their proceedings to land drainage and surface water—a description of which was to be found in Columella's, Cato the elder's, and in Varro's works "de re rustica;"—any system like the modern sewerage did not exist at Pompeii, or in any other Roman town. Mr. Boulnois had adverted to the system of sewerage adopted in Paris, and he was sorry to observe that Lord Shaftesbury had praised that system in the House of Lords. The fact however was, that there was no sewerage, in one sense of the word, in that city, and although a few houses and hospitals were said to have had their sewage conveyed into the main drains, this practice rendered private parties liable to a heavy penalty, which the Municipality rigidly enforced. The whole extent of the main drains executed in Paris up to the year 1852 was about 90 miles, whereas the Commissoners of Sewers in our own metropolis had executed 35 miles in one year. All the sewers of Paris were large enough to allow a man to enter; the bottoms were segmental, and the minimum fall was about 2 in 1000. But in Paris there were cesspools beneath *every house*, and although great care and superintendence was exercised in their construction, and excellent materials were used (*meuliere and hydraulic lime*), the filtration from the cesspools was so considerable that the well waters had been pronounced by chemists to be unfit for the ordinary purposes of life. Any person who had walked the streets of Paris at night, could not have failed to discover that all these cesspools were necessarily opened occasionally. Mr. Burnell added, that it was too much the practice in blue-books and with Boards of Health to assume, when any convenient phrase or formula had been hit upon that it expressed a fact. Thus the terms "self-cleansing sewers" and "sewers of deposit" had been much used; but a sewer was a passive object, and consequently these expressions were as erroneous in grammar as they were repugnant to common-sense. The expressions "hill-top" and "valley-water" were exposed to the same comment. The Board of Health had laid it down as one of these "formulæ," that 80 gallons of water per diem should be allowed as a proper supply to each house, but at Croydon 200 to 500 gallons had been given to each house to carry out the cleansing of these—so-called—self-cleansing small tubular drains. Amongst the objections to back drainage one had been overlooked, namely, that the land upon which it was effected became public property, and therefore the introduction of the system would occasion an interference with private rights, to which the people of England were unaccustomed. Still cases might arise in which, from peculiar circumstances, back drainage might be desirable; and in the course of his own experience he had been asked by the Commissioners of Sewers to allow another property to be drained through that for which he was concerned; but on another occasion when he proposed back drainage for two houses, and offered to give up their yards to the public, the Commissioners of Sewers refused to allow it.

Mr. Papworth inquired what Mr. Bazalgette considered to be the greatest amount of internal pressure to which a 6-inch pipe would be subjected.

Mr. Bazalgette did not assume any pressure till a stoppage took place, and then it would depend upon the head of water.

Mr. Papworth then inquired what head of water could be stopped up in a 6-inch pipe?

Mr. Bazalgette said, that he was not prepared to answer that question from any practical experience.

Mr. Inman suggested that the answer would be given by Mr. Bazalgette's stating the hydraulic proof which he usually put upon drain pipes.

Mr. Bazalgette said, that hydraulic proof was not applied to the pipes; the actual test to which they were subjected was the external pressure which would crush them. The 6-inch pipes bore the test, but the 15 and 18 inch pipes were so frequently crushed, that until the manufacture was improved, the Commissioners would not use any larger than 12-inch diameter. In practice, it was found that the 6-inch pipes did not burst, but became stopped up. The external pressure would vary with the depth at which the pipes were laid, and the nature of the soil. He was not aware that pipes were proved by internal pressure, but he knew that when they were first introduced the Board of Health endeavoured to employ them as water-mains, and in those cases they burst, and iron pipes were substituted.

In answer to a question from Mr. Papworth, Mr. Haywood, C.E., said, that the gullies in Paris were not trapped, and that a vast quantity of fæcal matter passed into the sewers, notwithstanding the Municipal prohibition.

Mr. Burnell stated, that according to the experiments of M. Boussingault, there was at least ten times as much ammonia in the atmosphere of Paris as there was in the open country.

Mr. Haywood gave the particulars of the pipe sewer in Leadenhall Market, which had become stopped up, as stated by him at the last meeting. It was 135 feet long and 12 inches in diameter, with a fall of 1 in 120; eight houses drained into it, and these were all fitted with waterclosets and syphon pans. It was stopped up from end to end, and he was unable to state the cause, and whether it arose from preventible causes or not. No doubt pipes could be made strong enough to bear 200 feet head of water, but the difficulty was, to join them securely, and this was the cause of the failure when the Board of Health attempted to employ 2-feet pipes for water mains.

Mr. Doulton expressed his regret that views of the most opposite nature, and carried to the greatest extent in each direction, had been expressed by the advocates of the different systems of drainage. Thus they had at one time been told that there was no necessity for brick sewers at all, and at another that it was extremely improper to lay a 12-inch pipe under a carriage way. Again, a 4-inch pipe was said to be sufficient for any house drainage, and soon aftewards it was acknowledged, that though a 9-inch pipe might be sufficient, a 12-inch pipe would be better. At first, pipes were made exceedingly and injudiciously thin, but now it was contended that a 12-inch pipe should be 1½ inch thick. It appeared to him that the truth lay midway between these extremes. The same remark applied to the diagrams of the drains and sewers. In the blue-books there were illustrations of brick sewers which would almost prevent any person building a brick sewer again, whilst some of Mr. Boulnois' drawings showed such representation of defects and stoppages in pipes as would deter any one from laying down a pipe again; indeed, he believed these drawings would have produced a very erroneous impression if the apparent facts had not been modified by the remarks of Mr. Haywood and Mr. Bazalgette. Considering that the pipe sewers had been so recently introduced, that they were laid under very disadvantageous circumstances by persons unacquainted with the proper mode, and that many persons were prejudiced against them as a novelty, he thought it wonderful that there had not been more stoppages than had actually occurred. He attributed those stoppages to the defective way in which the pipes had been laid. Why a concrete foundation should be applied to brick and not to pipe sewers he could not imagine, and if concrete had always been applied to the latter, as it was now, he believed the occasional sinking would have been prevented. Mr. Haywood had very properly stated that pipes could be made of any required strength, and engineers and architects were to blame if they did not stipulate for a proper amount of strength. As soon as the rage for cheapness which existed a year and a half ago had subsided, the pipes were made thicker, but of course the cost was increased in proportion; and it should be borne in mind, that excellence in the manufacture was more essential than mere thickness, the thickest pipe not being always the strongest. A 12-inch pipe, 1 inch thick, if well vitrified, would be stronger and better than if its thickness were increased to 1¼ inch or 1½ inch, as the manufacture and burning would be better with the inch thickness. Experience had suggested many improvements in laying the pipes, and the failures bore but a small proportion to the amount of pipes laid. Pipes were now being laid with great prudence and judgment, in such a way that they might easily be approached from side entrances and examined, and they were laid in straight lengths and not upon the intricate system adopted two years ago. He did not consider the porous nature of brick to be favourable for the formation of the slimy coating to which some value had been attributed: the vitrified internal surface of the tube would be more certain in its effects.

Mr. Fowler observed that Mr. Boulnois had divided the subject into three branches, and that of these the first two had to his mind been satisfactorily disposed of. The third branch of the subject, that of *outfall*, or ultimate disposal of the sewage matter, remained for discussion, if the meeting thought it desirable; and he therefore proposed that its consideration should be adjourned till another evening.

Mr. Christopher differed with Mr. Bazalgette as to the greatest amount of deposit being found in old and abandoned sewers. In his own district (Hammersmith) there were two main sewers. One of these, which had only been constructed ten years, was frequently liable to most serious deposit, and had now been for three months in course of emptying by hand labour, being filled up to two-thirds of its capacity by solid deposit. The other was an older sewer (3 ft. 6 in.), and although there was a large flow of water down it occasionally, it also was being emptied. Mr. Bazalgette's theory as to the scouring power would not apply when a deposit had been formed; and the cleansing he had referred to absorbed the whole local sewer rate of 6*d.* in the pound, with the exception of a small margin for staff, &c., leaving nothing whatever towards constructing new sewers.

Mr. Bazalgette stated, that he had intended his remarks to be of general application. The sewers of London, for the most part, were clean where they had a tolerably good fall and a moderate quantity of water passing through them, and if the road-drift could not be carried away, they might be kept clear by raking. It was plain that the sewers mentioned by Mr. Christopher had not sufficient fall in proportion to the quantity of water passing through them to make them self-cleansing, and pipe sewers in the same circumstances would be constantly stopped up. In these instances, the deposit could be removed without disturbing the sewers or breaking up the streets, which would not be the case with pipes.

Mr. Pocock said, that in the question of sewers, as in other affairs, only practical men knew how and when to modify

the theory, as modified it must be occasionally. The frequent changes and interruptions which had occurred in the proceedings of the bodies having the management of the sewers, even when they were going on satisfactorily, had tended to impede rather than to promote improvements. He proceeded to narrate a case in which he was concerned, where he had erected, at different periods, two sides of a square. In the first instance, he had applied to the Westminster Commissioners for permission to put in a 3 ft. 6 in. sewer, which he thought large enough to drain thirty-six houses, and seeing no prospect for years of getting any outlet to the south, he proposed to connect this sewer with another to the northwards, and although certainly this was not the most direct way to the Thames, the Commissioners would not have objected to draining a level surface as he proposed, if it had not been for the opposition of an energetic theorist in the Board, who would not listen to the proposition, simply because the new sewer was to the north of the Thames, and therefore, as he contended, *must* drain directly towards it. The consequence was, that the Board, after several years delay, spent a considerable sum to lower a 2 ft. 6 in. sewer, into which he had to drain his 4 ft. 6 in. sewer (the size insisted on) through an intermediate 1 ft. 6 in. barrel drain. When the reign of this body had come to an end, he erected sixteen houses on the other side of the square, and again proposed a 3 ft. 6 in. sewer, but now nothing would do but a 9-inch pipe! This however he resisted, and was fortified by one of the contractors, who said he would advise him to have cesspools rather than a pipe sewer, and that he would build him a 3 ft. 6 in. sewer for the same cost as the 9-inch and 12-inch pipe sewer, to which the Board were at length willing to accede. He (Mr. Pocock) resisted the Board until his tenants complained, when he urged them to complain of him to the Commissioners, and the result was, that they gave way, and he put in the 3 ft. 6 in. brick sewer. Generally, although a 6-inch pipe would make a very good house-drain, it was impossible to use a pipe for a sewer in a public road with either economy or efficiency. The chief advantage of a pipe was its economy, and this advantage ceased if a pipe was more than 9 inches in diameter, for an 18-inch brick barrel drain was not more expensive than a 12-inch pipe. The frequent complaints against the opening of the public roads for the repairs of sewers, gas, and water pipes, sufficiently showed the tendency of the public mind, and should be a warning to advocates of pipe drainage.

Mr. Inman proposed the thanks of the meeting to Mr. Bazalgette and the other gentlemen who had given them the benefit of their experience, and moved the further adjournment of the discussion. He stated, that the use of drain tiles, and the system of flushing sewers were not modern inventions; that the latter had been found in the ruins of Fountains Abbey; and he described the ingenious system by which, in the time of Cardinal Wolsey, the water of the moat, which surrounded Hampton Court Palace, had been made to flush and carry off the sewerage of the palace. The original supply of water from Coombe was conducted under the River Thames by an aqueduct, known as the Longford river, and these services were maintained to the present time in perfect operation.

## MACHINERY FOR TREATING GOLD QUARTZ AND OTHER METALLIC ORES.

Lemuel Wellman Wright, *Patentee*, July 2, 1853

(*With Engravings, Plate* XXII.)

In no age—no epoch of time—has mankind been more energetic in exploring and investigating into the metalliferous ores underlying the surface of the earth. The vast discoveries which have been made in the present century at home, on the continent of America, the continental island of Australia, &c.; the number of people employed directly and indirectly connected with these discoveries, and the transfer of our redundant population to other lands, all combine to mark it as a march of improvement of the greatest and most significant importance to the whole habitable globe in regard to the development of new employment, frequent intercourse with the most remote portions of the world, and the progress of civilisation.

Some of the principal sciences are here essentially requisite, embracing a geological and mineralogical knowledge of regions, localities, and individual strata; the direction of lode; the dip and strike of beds where minerals are to be found; their classification; laws of matter; machinery to be employed in reducing and separating the ore; and the chemical mode of extracting the metals.

Geology, considered as including mineralogy, treats of the external configuration of the earth, tracing the windings and indentations of its shores, the inclinations of the soil, the directions of its mountains, and the courses of its rivers; all which is sometimes called Physical Geography. Penetrating the interior, it analyses the nature of its productions, determines the positions of the different layers and crusts of the earth, and describes the alterations which have taken place, and are still taking place, from the action of water, heat, electricity, and of the great energies of nature.

Chemistry is employed to recognise, by analysis or decomposition, what elements enter into the formation of a compound body; to determine, by synthesis or recomposition, what bodies will result from particular combinations; to describe the peculiar properties of each element or of each combination of elements. The Scientific Practical Machinist has to employ certain materials that will resist and endure, so arranged and designed in the best form, that by mechanical means and the employment of the least power, the forces of adhesion and cohesion may be entirely destroyed, without derangement of parts, with great economy in working;—he has to provide the means of converting substances apparently worthless into valuable products.

The Machinist must also provide means on a large scale for carrying out the views of the Chemist in regard to amalgamation and other processes, so as to economise labour and shorten the process; he must therefore have a knowledge of physics, the changes and laws to which matter is subject, and the mutual actions going on.

It is evident that science cannot exist, nor could its lessons be made productive by application, without machinery. In the history of every science we find the improvements of its machinery, the invention of instruments to constitute an integral part, applied science in all its forms, and the fine and useful arts, are the triumphs of mind gained through the instrumentality of machinery.

Each therefore has his own wide and extensive domain, demanding his attention and judgment; and therefore, supposing correct information is required about the best form of machinery to be applied, you must not consult the geologist, mineralogist, chemist, or mining agent, but the machinist or engineer, and *vice versa*.

Some minds, unacquainted with the application of machinery to certain purposes, are in raptures with something that is novel, and generally consult a geologist or chemist, who, also struck with its novelty without being able to inquire into its practicability, gives way to ecstatic delight (in a similar manner to an Indian who has seen something novel), and calls on the world to patronise it, without giving the subject that calm reflection and judgment, as to its applicability, durability, and fitness, which come within the province of the engineer. This has hitherto been the case,—the consequence has been failure, disappointment, and a retardation of mining operations.

Scientific practical means are still required for the purpose of permanently assisting those who are engaged, or those who intend to direct their attention to the development of mineral wealth at home and abroad, so as to economise time, lessen manual labour, and amply reward all.

The machinery hitherto employed has been unable permanently to succeed, although the talent of the United Kingdom, as well as that of other nations, has been continually directed towards this object; so as to bring into practical use, machinery so constituted and arranged in all its parts as to be capable of crushing, washing, and separating the necessary amount of metal from the ore, repay the adventurers, and at the same time combine durability under the very heavy work to which the machinery must be subjected.

The desired amount of work to be performed cannot, upon mechanical and chemical principles, be obtained when the crushing, washing, and amalgamating is performed in one and the same operation, as the amount of gold to be obtained will be diminished in proportion to the rate the machine is forced to obtain quantity. It has been found, from experience and vast outlay of capital, that nearly all the inventions of machinery hitherto applied to this important subject have failed more or less from proceeding on erroneous principles, coupled with the fact of the peculiar arrangement and combination of parts rendering them incapable of resisting the heavy work to which they were subjected. Their public support may solely be attributed to their novelty; and therefore, as a caution, mining adventurers, in deciding on machinery, should only be guided by practical results continued for a considerable period of time.

It may with truth be alleged that no system of heavy balls of iron, whether revolving on inclined or horizontal basins, can be recommended as practical, when considered in reference to the heavy work to be performed. In a system having a heavy metal ball or balls, say 2 tons weight, connected to and moving freely within a hollow vessel, the ball or balls resting on and moved by an inclined iron basin with teeth cast on its bottom, working into another bevil wheel connected with the prime mover, a great many serious practical objections may be urged. If a large piece of quartz passes under the ball, it is raised from the basin, and again falls on it with a momentum due to two tons falling through the height raised; as this continually occurs during the first process of crushing, this succession of heavy blows disarranges the crystallisation of the iron, and will after a time fall to pieces. Again, there are difficulties connected with the teeth cast on the bottom of the basin, as they are liable to snap asunder, and the ball or balls will wear the inside of the basin into an irregular circular groove.

From the preceding observations, and an attentive consideration of the bearings connected wtih the important application of practical machinery to the wants of the miner, we have great pleasure in submitting for public approval and support, the recently patented machinery by Mr. L. W. Wright. The operations connected with Mr. Wright's Patent Machinery are divisible into four distinct and separate processes:—

1. Crushing the quartz or other material by degrees.
2 Pulverising the quartz or other material into an impalpable powder.
3. Mixing, washing, and separating the lighter from the heavier particles, according to their specific gravities, by means of centrifugal motion.
4. Amalgamation by quicksilver, and the application of steam to inside of machine, conveying heat to the washed and separated materials, and thus assisting the ready amalgamation.

### I.—Crushing Machine.

This machine consists of a heavy iron horizontal central driving-cylinder *a*, revolving on the same shaft as a heavy fly-wheel. Around the central cylinder are five smaller iron cylinders *b, b, b*, the shafts of which rest in adjusting blocks supported on projecting brackets of framework, provided with adjusting screws *c*, so that the cylinders can be placed in contact with central cylinder, or apart from it, as may be desired. The shaft of central cylinder and fly-wheel rests in plummer-blocks *d*, connected to iron framing. The two iron cheeks or frames *e, e*, are connected together by iron tie-rods. The machine is fed from a hopper *f*, fixed at the top.

*Action of Machine.*—Motion is conveyed from the prime mover to the central cylinder and fly-wheel shaft by means of a strap and pulley or bevil wheels *g*. The quartz or other material is fed through the hopper, and passes successively between the smaller and central cylinders, causing the smaller cylinders to revolve by contact, and is then received into a box situated below the machine. The distance between the smaller and central cylinders gradually diminishes until the fifth or last cylinder is in contact with it.

### II.—Pulverising Machine.

This machine consists of two vertical iron rollers *h, h*, weighing about five tons each, having solid peripheries connected to centre piece (through which a horizontal shaft *i*, passes) by a solid iron web. The rollers work loose on the horizontal iron shaft, the ends of which fit into grooves in iron steps, which are bolted to the framing. The rollers rest on a circular iron disc-plate *j*, on the bottom of which are cast strengthening-ribs. Iron gatherers are fixed to the inside of the disc to keep the quartz continually under the rollers.

A vertical iron shaft *k*, passing through the horizontal shaft, is connected to the circular disc-plate by means of bolts passing through the circular projecting piece of the vertical shaft, and screwed up on bottom of the disc by means of nuts. The bottom of vertical shaft is turned true, and works in an iron step fixed (at the ground-line) to the framing. The vertical shaft is driven by two bevil-wheels *l, l*, at its upper extremity, and conveys motion to the circular disc and to the rollers by contact.

*Action of Machine.*—The crushed quartz, being taken from the Crushing machine, is received on the disc-plate, and sufficient water added to form an adherent mass. Motion is conveyed from the prime mover to the bevil wheels, vertical shaft, the disc-plate, and iron rollers by contact, causing them to revolve in their own planes. The gatherers keep the material continually under the rollers until it is reduced to an impalpable mass.

### III.—Mixing, Washing, and Separating Machines.

The impalpable powder is put into the Mixing machine, which consists of a narrow, rectangular wooden vessel *m*, in which revolves an iron wheel *n*, provided with paddles. Sufficient water is allowed to run into the vessel until a certain consistency has been attained; the material passes under the paddle-wheel, where it is thoroughly agitated, and then flows down a trough *o*, connected near the top to the washing and separating machine.

The Washing and Separating machine consists of a wrought-iron cylinder *p* (shown in section), about 12 feet high and 7 feet diameter, having a spherical bottom. Inside of this cylinder revolves an agitator *q q*, which is connected to a vertical iron shaft *r*, driven by two bevil wheels *s, s*, in connection with the prime mover. At the bottom of the cylinder is an eduction-pipe *t*, for drawing off extraneous matters, fitted with a cock. The cylinder is also provided with another pipe *v*, fitted with a cock near the bottom of the cylinder for withdrawing the metals.

*Action of Machine.*—The machine is nearly filled with water, motion is conveyed from the prime mover to the bevil wheels and agitator, when the mixed quartz material is allowed to flow into the machine from the trough. The agitator is made to revolve at such speed as will be sufficient to suspend the earthy matters, causing the centrifugal force to throw the particles outwards from the centre of revolving column of semi-fluid mass, arranging themselves according to their specific gravities, the heaviest particles of the metals being near the axis of cylinder, and the lighter more remote. The heaviest particles, as gold and other metals, will gradually fall in or near the axial line of cylinder, and form a conical mass at the centre of spherical bottom, from which they can be withdrawn by the pipe and cock *t*, at the termination of the operation, through which the light extraneous associated matters are withdrawn.

### IV.—Amalgamating Machine.

This machine, which is shown in section, is similar to the Crushing machine; the only differences are, that the peripheries of the two rollers *u, u*, are convex, and work in a corresponding circular concave revolving plate *w*, space being left between the rollers and sides of concave plate for the separated and washed material to be amalgamated with quicksilver. The inside of the rollers is covered in, and each divided by four compartments connected by passages with hollow transverse horizontal iron shaft, *x x*, through which high-pressure steam passes. The condensed and blow-off steam finds egress from the rollers into the hollow horizontal shaft, and passes out near the vertical shaft or centre of machine.

*Action of Machine.*—Motion is conveyed from the prime mover to the bevil wheels, vertical shaft, concave plate, and rollers by contact with concave plate (as in the Crushing machine). High-pressure steam passes along hollow horizontal iron shaft to the different compartments in rollers, and thus communicates heat to the quicksilver and material placed in the concavity of disc, and accelerates the amalgamation; the condensed and blow-off steam passing off from the hollow horizontal shaft near centre of machine.

The advantages of the Machinery before enumerated may be briefly stated:—

1. The employment of separate machines, instead of performing all the processes in one operation. By this means we have greater regularity in feeding; a greater amount of quartz can be crushed, washed, and separated, and gold amalgamated, in a given time, without being obliged to force any of the processes.

2. The ore is reduced by degrees, by means of plain open surfaces, without complication in parts, using heavy cylinders capable of adjustment, and a heavy fly-wheel, which condenses and preserves a part of the power exerted previously to the commencement of the process; and having its force concentrated, its effects are exceedingly powerful; avoiding sudden shocks or blows, which deranges the crystallisation of iron, and tending to the ultimate destruction of the machine; the least susceptibility of derangement, and the slight uniform wear of every part.

3. The Pulverising machine does not receive any blows, on account of the quartz being reduced by the crushing process; and according to the fineness of the powdered quartz obtained by this machine, depends the efficacy of the washing and separating process.

4. The washing and separating process removes all the extraneous associated earthy matters, depositing together the heavy matters, as metals, in small bulk; so that when presented to the quicksilver the amalgamation is more rapid, and more gold obtained than by other machinery.

5. The use of high-pressure steam applied to the inside convex rollers; the increased facility given to the amalgamation by means of the circular concave plate; and the communication of heat from rollers to the quicksilver and materials.

6. The application of the machinery to metalliferous ores containing other metals, as copper, lead, &c., which do not require the amalgamating process.

## GRAND TRUNK RAILWAY OF CANADA—VICTORIA BRIDGE, MONTREAL.

The works of this important railway are making rapid progress towards completion. The total amount already received on account of the share and debenture capital of the Company (A series) is 1,525,250*l.*, of which 486,810*l.* is in advance on account of future calls. The arrears amount to 36,280*l.* The line from Montreal to Portland will be finished in July next; the junction from Richmond to Quebec, 100 miles in length, will be opened in August. The 392 miles of railway thus comprised will complete the communication between the three most important cities in the district.

In the event of the shareholders of the A series not taking up two-thirds in shares and bonds of the reserved or B series, the directors deemed it advisable to enter into the contracts for the prosecution of the works from St. Thomas, forty miles below Quebec (to join the Quebec and Richmond line), and between Montreal, Kingston, Toronto, Guelph, and Stratford, so that the line shall be opened from Montreal to Prescot, and between Toronto and Stratford, a distance of 210 miles, in the autumn of next year; and the other sections, giving a total length of 876 miles, in October 1856. The Directors have effected a satisfactory arrangement with the representatives, in England, of the Great Western Railway Company of Canada, by which both companies agree to suspend those portions of their respective lines that excited mutual jealousy.

Owing to the engineering difficulties to be encountered in spanning the river St. Lawrence in the vicinity of Montreal, it was deemed advisable to consult Mr. Robert Stephenson, who accordingly proceeded to Canada last year, and, assisted by Mr. A. M. Ross, the Company's Engineer-in-Chief, prepared a report, which we give in full, as follows:—

### Report of Mr. Robert Stephenson.

"Gentlemen,—Absence from England, and other unexpected circumstances, have prevented my sooner laying before you the results of my visit to Canada last autumn, for the purpose of conferring with your engineer-in-chief, Mr. Alexander Ross, respecting the Victoria-bridge across the river St. Lawrence, in the vicinity of Montreal. The subject will necessarily render itself into three parts, viz.—First, the description of bridge best adapted for the situation. Secondly, the selection of a proper site. Thirdly, the necessity for such a structure.

Regarding the first point, I do not feel called upon to enter on a discussion of the different opinions which have been expressed by engineers both in England and America, as to the comparative merits of different classes of bridge, and more especially as between the suspension and tubular principles, when large spans become a matter of necessity. It is known to me, that in one case in the United States a common suspension-bridge has been applied to railway purposes, but from the information in my possession from a high engineering authority in that country, the work alluded to can scarcely be looked upon as a permanent, substantial, and safe structure. Its flexibility, I was informed, was truly alarming, and although another structure of this kind is in process of construction near Niagara, in which great skill has been shown in designing means for neutralising this tendency to flexibility, I am of opinion that no system of trussing applicable to a platform suspended from chains will prove either durable or efficient, unless it be carried to such an extent as to approach in dimensions a tube fit itself for the passage of railway trains through it. Such bridge may doubtless be successfully, and perhaps with propriety, adopted in some situations, but I am convinced, that even in such situations, while they will in first cost fall little short of wrought-iron tubes, they will be more expensive to maintain, and far inferior in efficiency and safety. I cannot hesitate therefore to recommend the adoption of a tubular bridge, similar in all essential particulars to that of the Britannia over the Menai Straits in this country; and it must be observed, that the essential features being the same, although the length much exceeds that of the work alluded to, none of the difficulties which surrounded its erection will be involved in the present instance. In the Britannia, the two larger openings were each 460 feet, whereas in the proposed Victoria there is only one large opening of 330 feet, all the rest being 240 feet. In the construction of the latter, there is also every facility for the erection of scaffolding, which will admit of the tubes being constructed in their permanent position, thus avoiding both the precarious and expensive process of floating and afterwards lifting the tubes to the final level by hydraulic pressure. In speaking of these facilities, it is a most agreeable and satisfactory duty to put on record that the government engineering department has, throughout the consideration of this important question, exhibited the most friendly spirit, and done everything in its power to remove several onerous conditions which were at one time spoken of as necessary, before official sanction would be given for the construction of the work.

On my arrival in Canada, I found that Mr. A. M. Ross had collected so much information bearing on the subject of the site of the bridge that my task was comparatively an easy one. Amongst the inhabitants of Montreal, I found two opinions existing on this point—somewhat conflicting; the one side maintaining that the river should be crossed immediately on the lower side of the city, where the principal channel is much narrower than elsewhere, and where also the Island of St. Helen's would shorten the length of the bridge;—the other seeming to be in favour of crossing a little below Nunn's Island. Sections of the bed of the river at both points had been prepared, and a careful study of these left no doubt on my mind that the latter was decidedly the one to be adopted. In addition, however, to the simple question of the best site for the construction of a bridge across the St. Lawrence, my attention was especially called to the feasibility of erecting and maintaining such a structure during the breaking up of the ice in spring, when results take place which appear to every observer indicative of forces almost irresistible, and therefore such as would be likely to destroy any piers built for the support of a bridge. I have not myself had the advantage of witnessing these remarkable phenomena, but have endeavoured to realise them in my mind as far as practicable by conversation with those to whom they are familiar; and, in addition to this, I have read and studied with great pleasure an admirable and most graphic description, by Mr. Logan, of the whole of the varied conditions of the river, from the commencement of the formation of ice to its breaking up and clearing away in spring.* To this memoir I am much indebted for a clear comprehension of the formidable tumult that takes place at different times amongst the huge masses of ice on the surface of the river, and which must strike the eye as if irresistible forces were in operation, or such as, at all events, would put all calculations at defiance. This is no doubt the first impression on the mind of the observer; but more mature reflection on the subject soon points out the source from which all the forces displayed must originate. The origin of these powers is simply the gravity of the mass occupying the surface of the water with a given declivity up to a point where the river is again clear of ice, which, in this case, is at the Lachine Falls. This is unquestionably the maximum amount of force that can come into play; but its effect is evidently greatly reduced—partly by the ice attaching itself to the shores, and partly by its grounding upon the bed of the river. Such modification of the forces are clearly beyond the reach of calculation, as no correct data can be obtained for their estimation; but if we proceed by omitting all consideration of those circumstances which tend to reduce the greatest force that can be exerted, a sufficiently safe result is arrived at. In thus treating the subject of the forces that may be occasionally applied to the piers of the proposed bridge, I am fully alive to the many other cir-

* See *Journal*, Vol. XVI., 1853, p. 245.

cumstances which may occasionally combine in such a manner as apparently to produce severe and extraordinary pressure at points on the mass of ice or upon the shore, and consequently upon the individual piers of a bridge. Many inquiries were made respecting this particular view, but no facts were elicited indicative of forces existing at all approaching to that which I have regarded as the source and the maximum of the pressure that can at any time come into operation affecting the bridge. I do not think it necessary to go into detail respecting the precise form and construction of the piers, and shall merely state, that in forming the design, care has been taken to bear in mind the expedients which have hitherto been used and found successful in protecting bridges exposed to the severe test of a Canadian winter, and the breaking up of the ice of frozen rivers.

I now come to the last point—viz., the necessity of this large and costly bridge. Before entering on the expenditure of 1,400,000*l.* upon one work in any system of railways, it is of course necessary to consider the bearing which it has upon the entire undertaking if carried out, and also the effect which its postponement is likely to produce. These questions appear to me to be very simple, and free from any difficulty. An extensive series of railways in Canada, on the north side of the St. Lawrence, is developing itself rapidly; part of it is already in operation, a large portion fast progressing, and other lines in contemplation, the commencement of which must speedily take place. The commerce of this extensive and productive country has scarcely any outlet at present, but through the St. Lawrence, which is sealed up during six months of the year, and therefore very imperfectly answers the purposes of a great commercial thoroughfare. Experience, both in this and other countries, where railways have come into rivalry with the best navigable rivers, has demonstrated, beyond the possibility of question, that this new description of locomotion is capable of superseding water-carriage wherever economy and despatch are required; and even where the latter is of little importance, the capabilities of a railway, properly managed, may still be made available, simply for economy. The great object, however, of the Canadian system of railways is not to compete with the river St. Lawrence, which will continue to accommodate a certain portion of the traffic of the country, but to bring those rich provinces into direct and easy connection with all the ports on the east coast of the Atlantic, from Halifax to Boston, and even New York, and consequently, through these ports, nearer to Europe. If the line of railway communication be permitted to remain severed by the St. Lawrence, it is obvious that the benefits which the system is calculated to confer upon Canada must remain in a great extent nugatory, and of a local character. The province will be comparatively insulated, and cut off from that coast to which her commerce naturally tends; the traffic from the west must either continue to adopt the water communication, or, what is more probable—nay, I should say certain—it would cross into the United States by those lines nearly completed to Buffalo, crossing the river near Niagara. No one who has visited the country, and made himself acquainted only partially with the tendencies of the trade which is growing up on all sides in Upper Canada can fail to perceive, that if vigorous steps be not taken to render the railway communication with the eastern coast through Lower Canada uninterrupted, the whole of the produce of Upper Canada will find its way to the coast through other channels; and the system of lines now comprised in your undertaking will be deprived of that traffic upon which you have very reasonably calculated. In short, I cannot conceive anything so fatal to the satisfactory development of your railway as the postponement of the bridge across the river at Montreal. The line cannot, in my opinion, fulfil its object of being the high road for Canadian produce until this work is completed; and looking at the enormous extent of rich and prosperous country which your system intersects, and at the amount of capital which has been already or is in the progress or prospect of being expended, there is, in my mind, no room for question as to the expediency—indeed, the absolute necessity—of the completion of this bridge, upon which, I am persuaded, the successful issue of your great undertaking mainly depends.

I am, &c.,

ROBERT STEPHENSON.

*24, Gt. George-street, Westminster,*
*May 2nd*, 1854."

## IRON FLOORS—WAREHOUSE, CORPORATION-STREET, BELFAST.

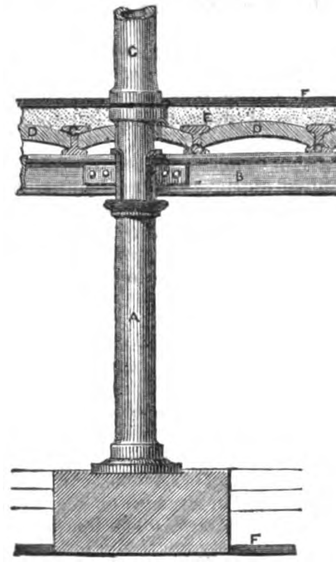
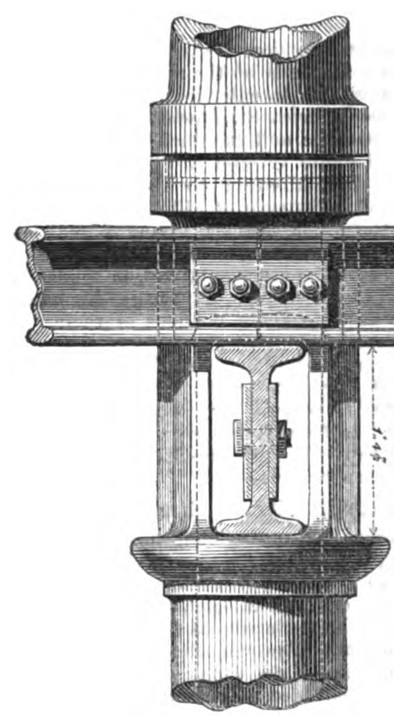


FIG. 1.

FIG. 2.

FIG. 3.



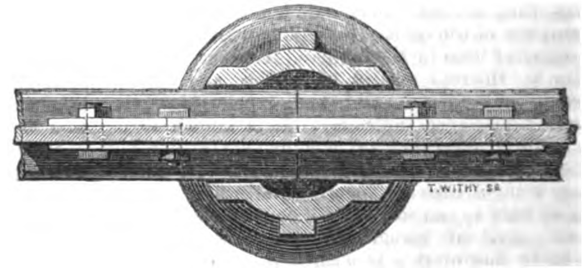


FIG. 4.

THIS extensive warehouse has been recently erected by Mr. Thomas Jackson, of Belfast. The frontage is 50 feet, and depth 40 feet. It is five stories in height, and has the floors and roof constructed on Messrs. Fox and Barrett's principle, with the exception of arches of perforated bricks, springing from the iron joists, and laid to a flat curve in Roman cement—being substituted for the wooden strips adopted by Messrs. Fox and Barrett. The annexed engravings represent the detail and method of rendering the floors fireproof. Fig. 1 is an elevation of one of the columns supporting the ground-floor, and showing the brick arches and joists in section; fig. 2 is a view showing the girders in section, and eyes in the top of the columns for receiving the same; fig. 3 represents a view of the column, joists, and girders on a larger scale; and fig. 4 a sectional plan of the same. A, is the lowermost column of the stack; B, the rolled iron girders, 8 inches deep with 4-inch flanges, which pass through the head of the cast-iron columns, and carry the rolled iron joists C, 5 inches deep with 2½-inch flanges; D, D, are the arches of perforated brick, springing to a flat curve from the flanges of the joists, and covered by a layer of concrete E, upon which is laid the seyssel asphalte floor.

The floors and roof are approached by a spiral staircase of cut stone, in a tower exterior to the rear wall of the warehouse. The building is occupied as a flax, yarn, and linen store. The ground upon which the warehouse stands is (like a considerable portion of Belfast) very soft and yielding, being an alluvial deposit of sand, shells, &c., to a depth of about 38 feet below the surface, under which is a bed of retentive blue clay. Piles of 40 feet in length were accordingly driven in, in double rows, with four under each metal column. The heads of the piles are about 4½ feet below the surface, to allow of a strong Memel framing above, united by bolts, straps, &c., and filled in between and at either side with closely-built brickwork, set in hydraulic mortar. On this is laid a course of sandstone, 4 feet broad, and 10 inches thick, in large slabs, roughly squared and dressed, in order to embrace the framing and footings on each side.

The front of office story, to the level of first ware-room floor, is of chiselled sandstone, channel-jointed, as also the cornices, copings, stringcourses, window-sills, &c. The stone was procured from the Kenmuir Quarries, near Glasgow. The rest of the walls are built of Beart's perforated bricks.

The asphalte flooring and roof was laid by the Metropolitan Mineral Rock Asphalte Company, and the joists and girders were rolled at the Bedford Iron Works.

## RAIN AT DIFFERENT ELEVATIONS.

By Thomas Hopkins, M.B.M.S.

Much labour has been employed to ascertain what are the quantities of rain that fall at different heights in the atmosphere, in the same locality. Assuming that the theory of the formation of rain which has been here advanced, is substantially correct, it will be apparent that the relative amounts that fall at various elevations, in a vertical column, will not be the same. When a large quantity is formed within a cumulous cloud and carried to a great height, where, through the expansion of the atmospheric gases, the drops of rain are thrown off laterally to a considerable distance into cold air, they may soon acquire a temperature as low as that of the clear air at the superior elevation;—and should they afterwards, in their fall to the earth, have to pass through warm air fully charged with vapour, the cold of the rain would condense upon the drops some of the vapour, when each drop would be enlarged in its descent. These drops, if collected at different elevations, would obviously, as they approached the earth, furnish larger quantities of water.

But the rain from a cloud may fall not beyond, but within the warmth of that cloud, and consequently may itself continue warm for the elevation, as long as it remains within the cloud, and the part of the atmosphere below the cloud and nearer to the earth, may be sufficiently dry to cause evaporation to take place from the surface of each drop of rain whilst it is falling. Each will then become smaller as it descends, and the whole of them will successively constitute smaller quantities of water the nearer they approach the earth, as could be shown if rain gauges were placed at various heights to receive it. It is, indeed, apparent that in this way some rain that has been produced in the higher regions of the atmosphere, often wholly evaporates during its descent, whilst other rain may bring to the earth only a small part of that which was falling at a great height.

Let us suppose a wind to blow against the sloping side of a ridge of land, rising to a height of say 1600 feet, and suppose this wind at the level of the sea to have a temperature of 57°, and a dew-point of 52°. It is evident that the part of the wind near the surface would pass over all the lower portion of the slope and up to 1500 feet as a dry wind, neither producing rain nor forming cloud;—because the air from the low level would not be sufficiently raised and cooled in its ascent to condense any of the vapour which it contained. But when this air was driven to the top of the slope, it would be sufficiently cooled by expansion to form cloud. Under these circumstances, rain might form near the top, whilst it would be fine weather over the lower part of the slope.

But suppose the wind at the surface to have a dew-point of only 4° instead of 5° below the temperature, and it will be perceived that the cloud would then be formed, not only near the top, but down to a level lower by 400 feet; and any rain that might fall from the cloud, might alight on the whole of the slope that was between the top and 400 feet below it. If the dew-point were only 3° below the temperature at the surface below, cloud would begin to form 700 feet lower than the top, and generally in such a wind the nearer the dew-point approached the temperature at the level of the sea, the lower would cloud form against the slope of the hill, from which rain might fall. As the dew-point at the surface, however, is seldom as high as the temperature, but in general considerably below it, it follows that rain will seldom fall from a cloud that is near the surface, over either the sea or the low ground. But it will often fall from a small height above the sloping sides of rising land and more especially against the higher parts of such land. Where rain is produced near the level of the sea 50 days in the year,—it may occur against a height of 1000 feet 100 days, and at a height of 2000, 150 days. Hence in many places it rains more frequently against the sides of hills than on the sea shore, or the low intervening ground.

Cloud is however formed and rain falls from it, not merely in that part of the atmosphere that is near the surface of the earth, but also at very considerable heights above it. As we ascend from a low level in the open atmosphere, the dew-point ordinarily approaches nearer to the temperature, until at some moderate, though varying, height they often are the same, when cloud begins to form. And a whole column of air so circumstanced, being carried against the slope of rising land, would be all raised, and the upper as well as the lower part of the column would be cooled by the diminution of incumbent pressure, and that portion of the atmosphere which had its dew-point nearest to the temperature, would have vapour within it converted into rain the earliest; so that even over hills rain may be produced at a considerable height above the surface of the ground. The rain which descends on low lands, as well as on the sea, generally comes from a considerable height in the atmosphere; this is known and acknowledged, whilst it is commonly supposed that that which falls against the sides of hills is always produced near their surfaces; this, however, is not necessarily the case, as the rain there, as in other parts, may be formed at considerable heights above the surface. The actual heights at which clouds are formed by ascending streams of moist air, are determined by the degrees of saturation of the different strata of the atmosphere; but when a portion of the lower air is taken to a great height, and there allowed to expand in full proportion to the diminished pressure, a moderate degree of saturation near the surface is sufficient to produce cloud. Winds, however, when they blow against the sides of hills, often convey portions of air saturated in various degrees at different elevations, from low levels to superior heights, and thus produce clouds and rain at various elevations.

Again, the whole of a thick stratum of air may, with due relation to the height of each part, be so fully saturated with vapour as to permit the cold consequent on a small rising to form cloud in nearly every part of it; or, the cloud may form first at the top, or at the bottom, or in any other part of the stratum, according to the degree of saturation of the part, and the cold of the elevation that is attained; and each elevation, as has been shown, is liable to be temporarily saturated by conversion of floating cloud into vapour. It is obvious too that, while a wind is blowing, each part of the land will not receive all the rain that is formed directly over it,—but only that which descends to it, the remainder being carried on by the wind;—and in hilly countries it may, and indeed does commonly fall against the rising ground. The higher ground thus frequently receives not merely the rain which is formed directly over it, near the surface, but also, successively, parts of that which had been formed over lower levels, but at greater distances from the surface: and the highest ground may consequently receive portions of what had been formed at different elevations above all the lower levels.

It may possibly be supposed, from what has been here advanced, that when a stratum of saturated air is moving over flat ground, the motion alone of the air would not produce cloud, or rain, but that it required to be forced up a hill to produce such a result;—this, however, would not be correct. The atmosphere, in moving over the surface of the globe, presses on the lowest level with a certain force:—this creates friction, which retards the advance of the lowest part of the air, and the retardation is successively communicated, though in inferior degrees, to the higher parts. The less retarded and higher parts, therefore, climb and pass over the lower until the air which in a particular locality constituted the lowest stratum, attains a considerable height, where it expands and acquires the temperature belonging to the superior elevation, when rain may be produced. Against the sloping sides of rising ground, both the causes that have been here pointed out are in operation during a wind, producing a rise of the air through its being forced up a hill by its horizontal motion, and also through retardation in the lower part by friction against the surface, and both of these causes contribute to the production of rain in such situations.

A direct line drawn through the atmosphere from the western edge of Lancashire, to the top of the ridge which separates that county from Yorkshire, would be, say about forty miles in length. Now, if the land rose parallel with that line, from the operation of the causes just explained—rain coming from the west would, on an average of years, fall along the line in quantities increasing with, and determined by, the elevation of each part. The quantity might be, say 20 or 30 inches in the year at the western edge, and 40 or 60 inches, or some other quantity, at the highest part, the intermediate parts having quantities proportioned to the elevation of each part. That we have not such regularly increasing quantities of rain now actually falling along the line, is attributable to the irregularities of the ground, and even to the trees and buildings, which produce partial obstructions, cross currents and eddies, varying to all conceivable extents. But the surface of the earth at the various levels, as well as the sea, has, as has been already explained, a supply of rain which is produced by a different cause, namely, the daily heating of the air, near the surface, by the sun. This, however, has been fully treated of in former papers.

In stating that much rain frequently falls among hills, it is not intended to intimate that the quantity goes on increasing with the height of the hills, however lofty they may be. The probability is, that over each rising land the quantity of rain increases up to some certain height—above which it diminishes, until at some elevation no rain will fall;—these heights will vary according to the temperature and dew-point of the locality. Where both temperature and dew-point are high, a strong ascending current may be produced, and the maximum quantity of rain may fall at a considerable elevation: where both are lower, the maximum quantity may be found at a much lower level. The greater or less continuity of the rain will also have its degree of effect. Continuous rain warms the atmospheric space up to a height greater than an occasional shower does, and that warmth may prevent condensation taking place from new supplies of vapour until they attain a higher level; whilst a large part of the vapour which a sudden cool and moist wind may bring, may be condensed at a moderate height, if the locality has not been previously warmed by condensation. When the atmosphere is fully saturated with vapour and the dew-point is at 80°,—as has been already stated, the vapour constitutes about one forty-eighth part of the whole, whilst with a dew-point of only 32°, the vapour is only one two hundred and fortieth part of the atmosphere. Now if from any cause air with a dew-point of 80° should be raised to a height that will reduce its temperature below that degree, it will evidently have a part of its vapour condensed. And if this air should ascend high enough to be cooled down to 32°, it must have all its vapour between the 48th and the 240th part of the atmosphere, converted into water to fall as rain. It is evident, therefore, that the greater part of the vapour which ordinarily exists in ascending moist air, must be condensed at some moderate height, seeing that but little of it can, in an aëriform state, pass into the very cold elevated regions of the atmosphere. The ascent to the upper regions being accompanied by decrease of temperature, whatever point of tropical heat at the surface we start from, the constant decrease of temperature will at last find the point of condensation, and therefore within some limit the cold will condense nearly all the vapour contained in the air, and above that limit but little rain can fall, because there is but little vapour left to produce it. If rain began to descend as soon as condensation of the vapour commenced, it would not be difficult, in a given state of the atmosphere with relation to the temperature and dew-point, to determine at what heights the various quantities of rain would be formed; but when it is formed, heat is liberated and an ascending current is produced, and we do not know what will be the temperatures and ascending forces of the currents. although we do know that as the air rises it must be under the influence of laws of expansion and cooling, and that the vapour which it contains is under those laws of condensation, and of liberation of heat, to which it is subjected in our mixed atmosphere.

The ridge of the Yorkshire hills, already alluded to, may be considered as 1600 feet high. The ridge of Helvellyn may be taken at 3000 feet; Ben Nevis as 4000 feet; and the highest ridge in Norway, as 8000 feet in height. Now let us suppose the same wind to blow against the western side of all these ridges, which wind near the surface of the globe has a temperature of say 57°, and a dew-point of 52°, a kind of atmosphere not uncommon in the summer of this part of the world. When it rose to a height a little above 1500 feet, it would average a temperature of 52°, the same as the dew-point, and, when passing over the Yorkshire hills, would form a slight cloud. In ascending Helvellyn it would, at the top, have a temperature of say 47°, and the vapour which it had contained between the dew-point at the surface and the temperature at the top of the mountain would be condensed, and some of it might fall as rain. The same wind, in climbing Ben Nevis, would acquire a temperature of less than 44°, and vapour would be condensed until the dew-point was reduced to that degree. In ascending the mountains of Norway, the freezing point would be reached at a height of 7500 feet, when all the vapour which the wind had contained between the dew-point of 52° at the surface and of 32° at the height of 7500 feet, would be condensed, and might fall as rain. Now the atmosphere of 52°, with a dew-point at the same degree, has vapour amounting to say a 120th part of the whole, whilst an atmosphere with a temperature and dew-point of 32° has vapour to the amount of only a 240th part, or not more than half the first named quantity. So that omitting the influence of heating by condensation, one-half of the vapour which the supposed atmosphere contained when at the level of the sea, where it would appear a clear and dry air, would be condensed, and might fall as rain, when it ascended to a height of 7500 feet. And any further condensation of the remaining vapour that might take place at a greater height, would be followed by congelation; and snow, instead of rain, would be produced.

Mr. Miller, in a paper read to the Royal Society, on May 18, 1848, gives a number of important meteorological facts relating to the Lake district of Cumberland and Westmoreland. The statement of the falls of rain that take place in many parts of this locality are very valuable, on account of the different heights of the parts above the level of the sea where the rain gauges were placed, and the particular shape of the face of the country. For a long time it had been known that the fall of rain became greater, as the ground rose from the low level of Lancashire to the top of the ridge which separates that county from Yorkshire; and it appears that the same general fact is, to a certain extent, observable in Cumberland, Mr. Miller having found that the fall was small at Whitehaven and other places in the low country near the sea, compared with that which took place up the valleys and on the mountains of the interior country. And that gentleman, after stating many facts, attempts to exhibit a law which determines that the amount of rain shall increase up to a certain height, and decrease above that height. He says—"It seems probable that in mountainous districts the amount of rain increases from the valley upwards to an altitude of about 2000 feet, where it reaches a maximum, and that above this elevation it rapidly decreases." Now, although the facts thus given are important in themselves, and afford a certain degree of countenance to the hypothesis advanced; yet neither the facts nor the reasonings founded on them are sufficient to warrant the general conclusion drawn from them by Mr. Miller.

A return is given of the quantities of rain that fell in twenty different places in Cumberland in the four years 1845-6-7 and 8; and of these places we may, in the first instance, take three as a sufficient number to show how far the facts harmonise with the law thus laid down, namely, Whitehaven, Wastdale-head, and Seathwaite—the first being on the sea-coast, the second, inland, at the mouth of the mountain pass of Sty-head, and the third, beyond that pass, and in the valley of Borrodale. In these three places there fell in the years named the following quantities of rain, namely:—

| | At Whitehaven, 90 Feet above the Sea, in inches. | At Wastdale Head, 166 Feet above the Sea, in inches. | At Seathwaite, 240 Feet above the Sea, in inches. |
|---|---|---|---|
| 1845 | 49·207 | 108·55 | 151·87 |
| 1846 | 49·134 | 106·93 | 143·51 |
| 1847 | 42·921 | 96·34 | 129·24 |
| 1848 | 47·344 | 115·32 | 160·80 |
| Mean | 46·589 | 106·60 | 145·63 |

Now, the differences in the heights of these three places are not very great, but the differences in the quantities of rain that fell are enormous—quite enough to warrant a suspicion, that the very large amount that fell at Seathwaite is not attributable to the height of that place above the sea. But in addition to those three places, there is the Pass of Sty-head, 1290 feet high, situated between Wastdale-head and Seathwaite, on which a rain-gauge was placed; it is, however, so cold there in the winter, and the gauge is so much affected by snow and ice at that season, as to prevent reliance being placed on it during that portion of the year. Yet we may compare the quantities of rain that fell in the summer months only at Sty-head and Seathwaite, as given by Mr. Miller—they are for the six summer months of 1848—

| | Inches. |
|---|---|
| Seathwaite, 240 feet above the surface of the sea | 68·96 |
| Sty-head, 1290 feet above the surface of the sea | 60·35 |

Here we find no increase in the quantity of rain that falls above 240 feet of height where the gauge is placed in Seathwaite. On the contrary, the quantity is greater there than at Sty-head, 1050 feet above it. This fact furnishes rather strong presumptive evidence, that the quantity of rain that is received in a gauge, at any particular elevation, is not proportioned to the height at which the gauge is placed.

In comparing the quantities of rain that fall at various heights, including great elevations, it is obviously necessary to compare them during the summer months alone, as has been done when comparing Seathwaite and Sty-head Pass; and the facts that are principally relied upon by Mr. Miller, and from which he draws his general conclusions, are the quantities of rain that fell in twenty-one months in 1846 and 1847 in six places, namely:—

| | | Inches. |
|---|---|---|
| The Valley (Wastdale) | 160 feet above the sea, | 170·55 |
| Sty-head | 1290 " | 185·74 |
| Seatoller | 1344 " | 180·23 |
| Sparkling Tarn | 1900 " | 207·91 |
| Great Gable | 2925 " | 136·98 |
| Scaw-fell | 3166 " | 128·15 |

But these facts although they countenance the hypothesis advanced, do not afford conclusive, or even strong, evidence upon the subject. The Valley we see, 160 feet high, has 170·55 inches; whilst Seatoller, 1344 feet high, and consequently 1184 feet higher than the Valley, has only 180·23 inches, not 10 inches more of rain; whilst Sty-head, 54 feet below Seatoller, has 5½ inches more of rain than that place. There is another place noticed by Mr. Miller, called Brant Rigg, 500 feet high, between the Valley and Sty-head, which received 12½ per cent. less of rain than the Valley, which is only 160 feet high, showing that here less rain fell in the higher than in the lower parts; and there are other anomalies that might be pointed out. It is, however, such a place as Seathwaite that shows, in the most palpable and striking way, that the amount of rain which is received by the ground in a particular locality is not determined by its height. Seathwaite, not more than 240 feet above the sea, receives more rain than any of the places having a greater elevation; and Mr. Miller candidly admits that he is "unable to offer any satisfactory reason for the great excess of rain at Seathwaite over all other valleys."

In order to account for the great and unequal quantities of rain that fall in different parts of this district, it is necessary that we should remember the causes which determine the formation of rain at various heights in our atmosphere, as already explained. The following figures will show the heights at which vapour would be condensed under certain circumstances; that is to say, with the air and dew-point of the vapour at the surface both at 59°, when the tension of vapour is equal to half an inch of mercury, the wind at the time blowing up a valley and sloping sides of a mountain. The lowest stratum of air being 59°, the temperature and dew-point would be reduced at a height of—

| | | |
|---|---|---|
| 300 feet to 58° | 1200 feet to 55° | 2100 feet to 52° |
| 600 feet to 57° | 1500 feet to 54° | 2400 feet to 51° |
| 900 feet to 56° | 1800 feet to 53° | 2700 feet to 50° |

And all the vapour that existed in the air between the dew-points of 59° and 50° would be successively condensed by the time that the air and vapour reached the height of 2700 feet, and rain, the product of that amount of condensation, would be produced at the various heights as the cooling proceeded.

There is, however, a second process going on under such circumstances as those just described, which, as it modifies the first, it is necessary again to notice. When condensation of vapour takes place heat is liberated, and the temperature of the locality is raised. The gases in the part are then warmed, and they expand and ascend to a greater height, where they are further cooled, and where they condense more vapour. So that the vapour is condensed in the first place by the atmospheric mass being forced up the inclined plane of the land, mechanically, as a wind—and, secondly, by the ascent produced by the heating power of condensing vapour; and whilst the mass of air and vapour is carried up from both these causes, it is moving forward horizontally as a wind. In the locality, then, the wind moves mechanically towards the upper part of the valley, whilst from the heating effects of condensation, it is ascending above that part; the condensing vapour will therefore be liable to be carried above the highest part of the land, and the greatest quantity of rain may fall beyond that part. And, further—after the vapour has been condensed, and the rain formed at a certain considerable height in the atmosphere, it has to descend from that height, and will be liable, while so descending, to be carried forward horizontally by the wind, and will reach the earth at a part beyond that over which it was formed.

Now, to apply this general statement and reasoning to the case under consideration: let us suppose that air saturated with vapour of the temperature of 59° passes from the sea-coast, near Ravenglass, towards the mountains as a south-west wind. When this wind reaches land 300 feet high, it will be cooled by ascent 1°; and will have all the vapour condensed that is contained between a dew-point of 59° and one of 58°. When it reached land 600 feet high, 2° of vapour would be condensed; 900 feet 3°, and so on in succession, 1° more for every 300 feet of height up which the air was forced mechanically. Add to this the vertical ascent produced by heat from condensation, and the actual progressive motion of the condensing vapour will be intermediate between the two. Supposing the two forces to be equal, the mass would proceed forward, ascending at the angle of 45°. Sty-head Pass is 1290 feet high—the atmospheric mass, therefore, when it reached Sty-head would be cooled, say 4°, and it would be liable to be carried over the head of the Pass, rising at an angle of 45°. We might therefore expect, from the known laws of condensation of vapour, and of the action of wind, that, under the circumstances described, a larger amount of rain would fall beyond Sty-head, than either in the approach to it, or on the top of it; and accordingly it is the fact that a larger quantity of rain falls in Seathwaite, which is a little beyond the Pass, than in any part between Seathwaite and the sea.

In such a locality the saturated air, forced by the rise of the land, to ascend, entering the wide mouth of the Valley, which contracts in breadth as it proceeds, rushes through the narrow gorge in the upper part, and over the top of the mountain pass, with great velocity and force; condensation, therefore, will take place to a greater extent along this particular and comparatively low line, than where the ridge of the mountain is higher by 2000 feet. The higher parts stop the passage of the wind, which makes its way where there is the least resistance, and this is over the pass of the mountain ridge; and as the horizontal rush of air is here particularly strong, any rain that is there formed, or that has been carried thither, will be liable to be borne forward until the air loses some of its velocity in the comparatively open space beyond the Pass where the rain is likely to be deposited—just as running water deposits sand when it reaches a wider and comparatively still part of a river. In the case stated, the air was supposed to be saturated with vapour, but if it should not be fully saturated, but have a dew-point of, say 1° below the temperature, the only difference would be that condensation would not begin until the mass of air climbed 300 feet,—a dew-point of 2°, 600 feet; and other dew-points in proportion.

We see, then, why the largest quantity of rain should fall in Seathwaite when a south-west wind blows from the sea over Sty-head, as Seathwaite is favourably placed to receive much of the rain brought by that wind; but other winds blow in this district during a large portion of the year, and as much more rain falls at Seathwaite than in any other part, these other winds must, we presume, also bring rain to that place. To see how this is effected, we have to examine the shape of the neighbouring country, and particularly in the directions from which rainy winds come; and we may perhaps obtain a tolerably good idea of what that shape is from an account given in Hudson's 'Guide to the Lakes.' In this work, page 118, it is said—"I know not how to give the reader a distinct image of the main outlines of the country, more readily than by requesting him to place himself with me in imagination upon some given point, let it be the top of either of the mountains, Great Gable or Scaw-fell; or rather, let us suppose our station to be a cloud hanging midway between those two mountains, at not more than half a mile's distance from the summit of each, and not many yards above their highest elevation; we shall then see stretched at our feet a number of valleys, not fewer than eight, diverging from the point on which we are supposed to stand, like spokes from the nave of a wheel." Now, this imaginary point in the air is nearly over Sty-head Pass. The writer then proceeds to describe Langdale, the Vale of Coniston, the Vale of Duddon, Eskdale, Wastdale, Ennerdale, and the Vale of Crummockwater, and Buttermere. And he goes on to say, that "such is the general topographical view of the country of the lakes; and it may be observed that, from the circumference to the centre, that is, from the sea or plain country to the mountains specified, Great Gable and Scaw-fell, there is in the several ridges that inclose these vales, and divide them from each other—I mean, in the forms and surfaces —first, of the swelling ground, next, of the hills and rocks, and, lastly, of the mountains—an ascent of almost regular gradation from elegance and richness to their highest point of grandeur and sublimity." Nearly all these eight valleys, in the low flat country, present wide openings to receive any wind that may be blowing towards them—they contract towards the centre where the ground rises; and the wind, whether it blows from, say, the south, south-west, the west, or the north-west, will force its way over the lowest points of the central chain, and be disposed to discharge rain on the country a little beyond those points. Borrodale is just in this situation, and must therefore receive rain from every moist wind that comes from a southern or western quarter, in the way that has been described; and Seathwaite seems to be in that part of Borrodale which receives the largest quantity of rain.*

The large fall of rain in this village is then to be considered a result of various rainy winds blowing up the different valleys, and particularly those which lie to the south and west of it, as those winds force the mixed masses of air and vapour to rise to the lower parts of the elevated ridges that are at the heads of these valleys. At or above these parts the vapour is largely condensed, and the rain that is formed is carried forwards and deposited on the low ground beyond the ridge; but though deposited there it evidently descends from a great height.

Speaking in general language, it may be said that the largest quantities of rain fall from warm and moist atmospheres, as such atmospheres contain the largest quantities of aqueous vapour; and the rain is formed by the condensation of a part of the vapour, at a height dependent on the elevation that is attained by the atmospheric mass when forced to ascend, and the difference between the temperature and the dew-point in that mass. If the rise of the land is great and abrupt, approaching a vertical cliff, the larger part of the rain might possibly fall on the low ground in front of the cliff, the mass of air being unable to pass over it, until such a height was attained as would leave little uncondensed vapour existing in the air. In such a situation it is evident, that one gauge placed at a low level in front of the cliff might receive more rain than another fixed at any height above it. And it is equally clear, that when rain is formed whilst passing over an elevated ridge, that rain might be received either in a gauge placed beyond it, only a little lower, or in one not farther beyond it, but fixed in a deep valley below, as is, in fact, the case with the gauge at Seathwaite. We may therefore conclude, that in a country containing lofty mountains and deep valleys, with much irregularity of surface, the height of the gauge into which rain falls does not indicate the elevation at which it was formed—that elevation being determined by the laws of cooling of the aqueous vapour that is contained in our mixed atmosphere, whilst the vapour is diffused through the gases.

* Since this was written, another part that is contiguous has been found to receive more rain. It is stated that the quantity of rain that fell annually at Seathwaite, on an average of five years, 1845 to 49, was 142·19 inches. In 1850, it was 143.96 inches, whilst it was computed that at Sprinkling Pass no less than 189·49 inches fell.

The following account has been furnished to me of the

*Fall of Rain in a year at Cuchullin Lodge, in the Isle of Skye, being the Mean of the Two Years, from Sept. 1, 1849, to Sept. 1, 1851.*

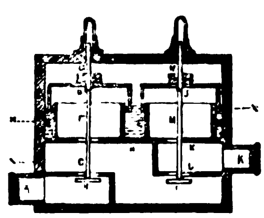
| | | | |
|---|---|---|---|
| January | 18·3 | July | 5·1 |
| February | 12·1 | August | 10·1 |
| March | 9·3 | September | 8·8 |
| April | 5·4 | October | 18·2 |
| May | 5·0 | November | 15·7 |
| June | 12·7 | December | 11·4 |
| Total for the Year | 132·1 | | |

## GAS METERS.*

MOSES POOLE, *Patentee*, August 8, 1853.

THIS invention consists in an apparatus for regulating the supply of gas or other aëriform fluid. The main or supply pipe, where the regulation is to take place, is arranged to communicate in succession with two or more chambers, each having a governor or regulator.

The annexed engraving shows a vertical section of an apparatus combined according to the invention, having two regulators or governors acting in succession, but other apparatus may be made with more than two to act in succession in a similar manner. The form of regulator or governor preferred is that where an inverted vessel is employed fixed to the valve, the action of which is to be regulated: but the form of the parts may be varied, so long as two or more regulators are combined to act in succession as herein shown and described. No claim, however, is made to the governors or regulators separately when two or more are not combined to act on and regulate the same supply. A, is the

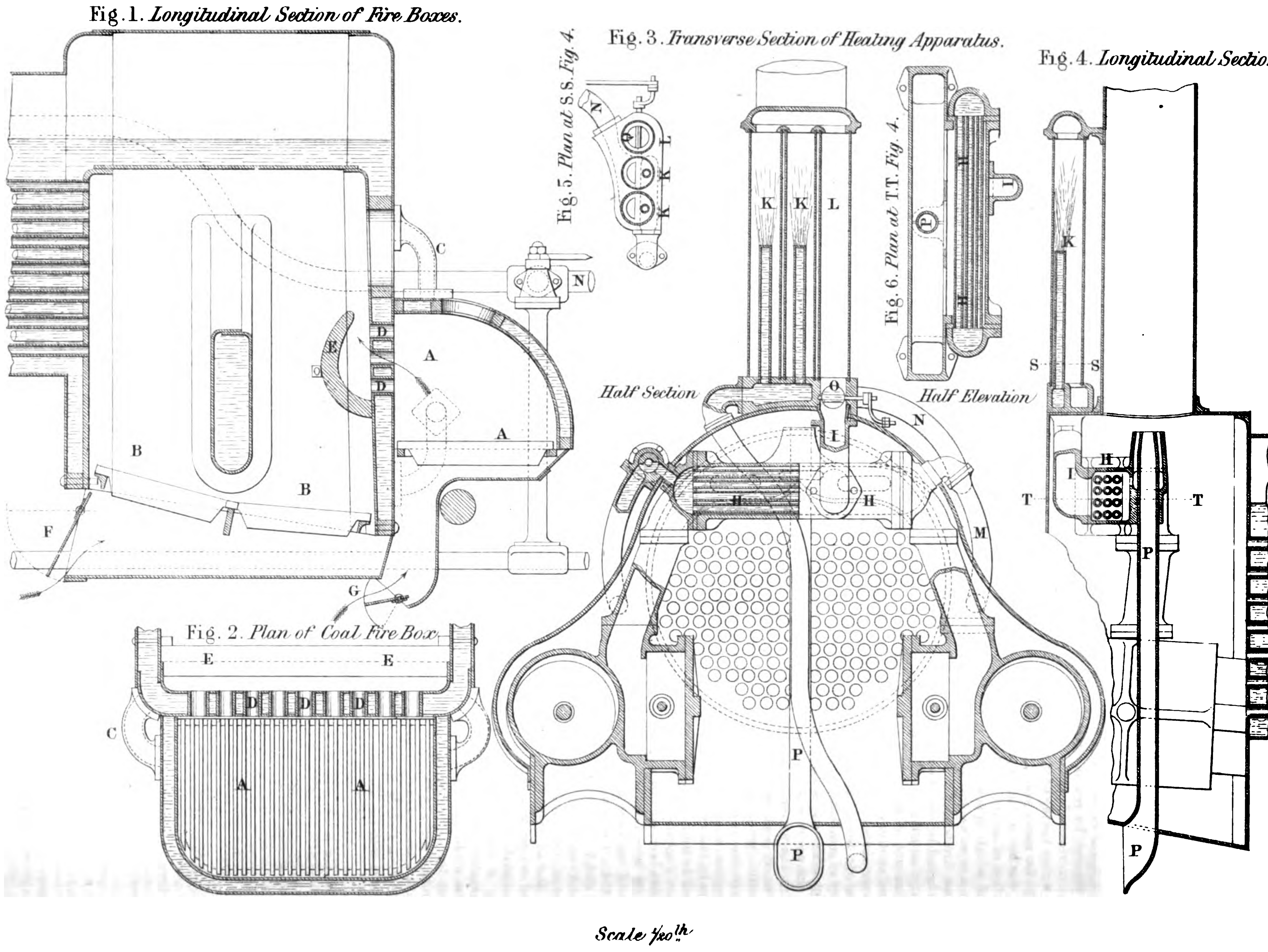


inlet for the gas or aëriform fluid; B, is a chamber, the opening C C, out of which is capable of being more or less closed by the valve O, which is on the stem F, to which the inverted vessel D, is fixed, the edges of which dip into mercury or other suitable fluid at E E, there being weights G G, on the vessel D, according to the degree of pressure it is desired to regulate or bring the supply of gas or other aëriform fluid to, when it passes away at the outlet K. The gas or other aëriform fluid coming into the chamber B (above the desired pressure), will to some extent be regulated by its acting on the first regulator by raising the vessel D, which will also raise the valve O, in the compartment B, towards the opening C C, till the quantity of the gas allowed to pass into the chamber H, of the apparatus will be brought to nearly the desired pressure. The gas or aëriform fluid in the chamber H, passes through the opening J J, into the compartment K, and acts on the inverted vessel L (which is affixed to the stem N), by which the valve O, in the chamber H, is more or less closed, according to the pressure of the gas or aëriform fluid in the chamber H, is more or less an excess of the pressure that it is desired the gas or aëriform fluid should go off at the outlet K. By using a succession of regulators or governors, any want of correctness of the regulation of the first will be compensated for by the succeeding one or ones.

*Claim.*—The combination of two or more governors or regulators so that they may come into action in succession.

* Reported in the 'Repertory of Patent Inventions.'

# IMPROVED LOCOMOTIVE ENGINE.



## IMPROVED LOCOMOTIVE ENGINE.*

By Joseph Beattie, of London.

(*With Engravings, Plate* XXIII.)

[*Paper read at the Institution of Mechanical Engineers.*]

The economy of fuel in working locomotive engines is a subject of great importance to railway companies, and has attracted considerable attention for many years; but at no period since the introduction of railways has this subject been of such moment as at the present, by reason of the great demand for coal, and consequent increase of price.

The writer having been connected with one of the metropolitan railways for many years, and coal being so very expensive in the south, was led to the consideration of economy in fuel and the production of steam at the lowest possible cost, the accomplishment of which appeared to be in the employment of coal to be used in a separate and distinct fire-box, but in connection with the coke fire-box of the locomotive engine; and this idea was strengthened by the observation of the working of coke ovens in the manufacturing of coke, where he often lamented to see the great amount of flame and combustible gases pass off into the flues and chimney without producing any useful effect; and when it is remembered that 1½ ton of good coking coal is required to produce one ton of coke, some estimate may be formed of the quantity of combustible gases that is thrown off.

Being anxious to secure the advantages which appeared to be got by the use of coal in connection with coke in the generation of steam, the writer considered the proper mode was to use coal and coke in separate furnaces, so arranged that the flame and combustible gases thrown off the coal fire would enter into and pass over that of the coke fire, and entering by short tubes into a combustion chamber, situated partly central between two sets of tubes in the cylindrical portion of the boiler, and where complete combustion would be effected.

A new engine on this principle has not yet been completed, but it has been applied in part to six engines with the ordinary boiler on the London and South-Western Railway, and the results of working have been found most satisfactory. One of them, the 'Britannia Engine,' with 15-inch cylinders, 21-inch stroke, and 7 feet driving-wheels, has been working since August 1853, and run 13,600 miles between Southampton and London, a distance of 78¾ miles, taking the regular running of passenger trains; the average consumption has been 17 lb. per mile, one-third of which was coal, but charged in weight as coke. An experimental trip was made with this engine by Mr. Edward Woods, in October last, with one of the passenger trains to Southampton, and back to London; and another experimental trip was made by Mr. W. P. Marshall, Secretary of the Institution, on the same engine with the 10·15 a.m mail train from London to Southampton, on the 17th January, returning with the 3 p.m train to London; the particulars of these experiments are appended, and the general results are as follows:—

*Experiments with the 'Britannia' Engine and Passenger Trains from London to Southampton and back.*

| | | Oct. 26, 1853. | Jan. 17, 1854. |
|---|---|---|---|
| Length of double trip with train | miles | 157½ | 157½ |
| Length of double trip with engine | miles | 161¼ | 161¼ |
| Down trip, average train | carriages | 12·8 | 11·2 |
| Down trip, average speed running | miles per hour | 31·4 | 28·3 |
| Down trip, number of stoppages | No | 8 | 8 |
| Up trip, average train | carriages | 18·5 | 19·3 |
| Up trip, average speed running | miles per hour | 29·4 | 27·5 |
| Up trip, number of stoppages | No | 7 | 7 |
| Total consumption of coke | cwt. | 16 | 18 |
| Total consumption of coal | cwt. | 8 | 8¼ |
| Total consumption per mile of train | lb. per mile | 17·1 | 18·6 |
| Total consumption per mile of engine | lb. per mile | 16·7 | 18·2 |
| Water evaporated per lb. of fuel | lb. | 8·3 | 8·1 |
| Average pressure of steam, down trip | lb. per mile | ... | 105 |
| Average pressure of steam, up trip | lb. per mile | ... | 100 |
| Greatest pressure during trips | lb. per mile | ... | 128 |
| Least pressure during trips (omitting last ten miles | lb. per mile | ... | 82 |
| Average pressure in up trip over 17 miles, rising 1 in 250, between Bishopstoke and Basingstoke | lb. per mile | ... | 122 |

The action of the coal and coke fire-boxes is as follows:—The coal fire-box A A, figs. 1 and 2, Plate XXIII., is attached to the back of the fire-box B B, of the ordinary locomotive engine, as shown in the plan, fig. 2, and placed partly below the foot-plate, the water-space of which is in connection with that of the coke fire-box by two branch pipes C C, at bottom and two at top. The flame and combustible gases thrown off the coal fire pass into the coke fire-box through tubes D D, inserted into the intervening water-space; and to promote the combustion of the gases, by giving more time for better admixture, a curved fire-tile bridge E, forming a sort of combustion-chamber, is placed within the coke fire-box, fronting the tubes leading from the coal fire-box, thereby checking the velocity of the flame in its passage over the surface of the coke fire. The coal fire-box and the coke fire-box are provided with separate ash-boxes and close-fitting dampers F, G, whereby the draught to each can be regulated with the greatest nicety, and independent of each other. The damper of the coke fire-box F, is generally kept nearly closed, and is only opened 1½ inch with trains of 20 to 24 carriages; but the damper of the coal fire-box G, is generally kept *quite* open, to admit the *full draught* of the blast, by which means, the coal fire being excited to the utmost, the gases and flame pass into the coke fire, and with them the air in a *heated* state; the high temperature of the coke fire is maintained, and more perfect combustion is the result. The combustion of the smoke is completely effected, the smoke being scarcely perceptible. An important practical advantage is gained from the circumstance of the ordinary coke fire-door being kept almost constantly closed, the door being opened only three times to put on coke during the whole trip of 78¾ miles, thus preventing the frequent rush of cold air cooling the fire-box and tubes, and causing a liability to leakage: in the present case, all the air entering at the coal fire-door, becomes highly heated before coming in contact with the main fire-box and tubes.

The next subject which attracted the author's attention was, the fact that all the water required for the supply of the engine when working was sent cold into the boiler, and to obviate this evil, attempts were made to warm the water in the tender by steam from the boiler *before* the engine started to work, but this was obtained at the *expense* of the fuel, and was only available as far as the first quantity of water in the tender would supply the engine. The next supply of water taken into the tender must be used cold, because the engine being *on the journey* could not afford to part with steam to heat the water, as in the first instance, before starting. The great evil of frequent loss of time in travelling was a consequence of the cold-water system of working, and so much was this felt, that when an engine was heavily loaded and taxed to her *utmost capability*, and having to ascend a long steep gradient, the extra steam to be generated to accomplish this task necessitated an extra supply of *cold* water to be pumped into the boiler, thus checking the generation of steam, reducing the pressure in the boiler, and crippling the engine. This evil being so great, the author attentively reviewed the whole action of the engine, with a view to improvement as well as economy; seeing that nearly the whole of the caloric which had cost so much was finally dismissed as useless at the chimney, it occurred to him that part of such caloric might be intercepted and communicated to the cold water used for supplying the boiler, a source of heat being thus available.

Various apparatus for this purpose have been contrived and put in operation, one of which is that attached to the 'Britannia' engine. It consists of an oblong rectangular chamber H H, placed in the smoke-box, and cast in one piece with the exhaust-pipe, and communicating to the upper part of the ordinary blast-pipe; this chamber is filled with a series of small tubes shown in section in fig. 3, fixed in tube-plates at each end, and communicating with inlet and outlet chambers in connection with the engine, pump, and boiler. A branch pipe I, from this rectangular chamber communicates with an outer condensing apparatus fixed in front of the chimney, consisting of three upright pipes K K L, standing on a cast-iron foundation, shown in plan in fig. 4, and connected at top by a hollow cap. Two of these pipes, K K, are provided with jets or injections supplied by the cold-water pump, which draws its supply direct from the tender. There is an overflow-pipe M, for conveying the water after it is heated to the hot-water pump, and an overflow-pipe N N, leading to the tender to convey any surplus water which may not be taken by the hot-water pump. The third upright pipe L, is provided with a disc or throttle-valve O, by which the exhaust steam from the lower chamber H H, can be admitted into the condenser. P P, is an air-pipe inserted in the centre of the orifice of the blast-pipe, with a funnel-shaped mouth at the lower end, to catch the air and assist the blast.

The action of the apparatus is as follows:—When the engine is working, the exhaust steam from the exhaust steam-pipe, before it reaches the orifice of the blast-pipe, fills the lower chamber, forming a steam bath around the small tubes (through which the water passes into the boiler), and flows upwards into the outer condenser, where it is condensed by the jets from the cold-water pump, and such water, together with that obtained from the condensed steam falling to the bottom of the condenser, is carried off by the overflow-pipe before named to the hot-water pump, which propels it through the small tubes in the lower chamber; and as the water passes slowly through these pipes on its way to the boiler, it absorbs heat from the constant supply of steam rushing to the condenser to be condensed, and enters the boiler at a very high degree of temperature, and causing little or no check to the generation of steam in the boiler, thereby maintaining the *full power* and energy of the engine. The average pressure in the experiment throughout the whole down trip was 105 lb., and 100 lb. in the up trip; the total fluctuation in pressure during the trip being very limited.

This is a desideratum of no small value, and is experienced especially in the working of the engine between Southampton and London, as there are many *long* and *sharp* gradients, particularly that between Bishopstoke and Basingstoke, the gradient averaging 1 in 250 for 17 miles; the Southampton, Portsmouth, Gosport, and Salisbury trains, being all joined at Basingstoke, and taken in one train to London, which generally contains from 20 to 26 carriages. The advantages of the improvements just described are particularly apparent whilst ascending this *long* gradient, as was shown in the experiment last referred to, in which a uniform pressure of 120 lb. per square inch was maintained up this incline of 17 miles 1 in 250, with a load of 21 carriages; in consequence a high rate of expansion could be employed throughout, the steam being cut off at 5 inches out of 21-inch stroke, or at less than one-fourth of the stroke during the whole time,—an important source of economy.

There are six engines, adapted for burning coal and coke upon this principle, working on the London and Southampton line (the 'Britannia' being one of them), whose united running amounts to 100,360 miles, and the average consumption of fuel, coal and coke together, has been 15·6 per mile, the 'Britannia' having run 13,600 miles with an average consumption of fuel of 17 lb. per mile. In conclusion, it may be remarked, that in no *one* instance have any of these engines failed in *any* part of the apparatus connected with these improvements; also the same remark applies to the fourteen other engines (although in daily use) which are furnished with the heating and condensing apparatus. Should any mishap occur, the engine-driver can cut off the communication from the heating apparatus in an instant, and supply the boiler and work the engine in the ordinary way, and without stopping the train.

## ON AN APPLICATION OF THE PROPERTIES OF THE WEDGE.*

### PROPOSED BY M. MINOTTO FOR IMPROVING THE METHODS OF TRANSMITTING MOTION IN MACHINERY.†

By H. Hennessy, M.R.I.A., Librarian to Queen's College, Cork

Among the most usual methods of transmitting motion from one part of a machine to another are trains of wheels, acting on each other either by friction alone, or more frequently by the contact of projecting teeth placed along their edges. The disadvantages of both of these methods have been so long recognised, that it would be almost superfluous to point them out; and any proposal which would be likely to remove such disadvantages must be regarded with considerable interest. In order to transmit force by a train of wheels, it is essential that their surfaces of contact should adhere with a force greater than that required to be transmitted. This adhesion will depend—1st, upon the nature of their materials; 2nd, the form of their surfaces of contact; and 3rd, the pressure at these surfaces. The second of these conditions is that to which the improvement proposed by M. Minotto refers. He proposed that the edges of every alternate wheel in a train of geering should be indented with a groove of trapezoidal section, the other wheels having each a corresponding truncated wedge-like projecting rim. The properties of the wedge immediately explain the object of such an arrangement. The power applied at the head of a wedge, or that side of it opposite the vertex, is to the resistances opposed by its lateral faces as the area of the head to the area of the faces; consequently, in an isosceles wedge with rectangular faces, if $i$, represent the angle at the vertex, $p$ the pressure at the head, P the pressure at one of its faces, we have

$$p = 2\,\mathrm{P}\sin. i; \text{ or } \mathrm{P} = \tfrac{1}{2}\,p \operatorname{cosec.} i.$$

Therefore, by diminishing the angle at the vertex we have a means for indefinitely augmenting the pressure exercised by the faces of the wedge. These results are evidently unaltered if the wedge is truncated; consequently, the adhesion at the surfaces of contact in such wheels as those described, may be made very great without augmenting the actual pressure between them, but simply by diminishing the inclinations of the surfaces of the truncated wedge in one, and of the groove in the other.

As the nature of the materials used in machinery must influence the adhesion at the surfaces of contact, some experimental illustrations of the resistance produced by the application of the wedge would be useful. From experiments made by M. Minotto on the motion of wedges of different angles and substances through grooves similarly varying in their angles and the substances of which they were made, he has drawn up a table of results, a few of which will serve to illustrate the point in question. A wedge of cast-iron with an angle of 30°, moving in a cast-iron groove with the pressure or weight 5, produced the resistance 3·75. A wedge of the same substance with an angle of 20°, and carrying the same weight, produced the resistance 5·06. Another wedge with an angle of 10°, and in all other respects similar to the last, produced the resistance 9·53. A wedge of brass, shaped as the last, and carrying the same weight, produced the resistance 10·60.

These experiments fully confirm the principle on which the wedge is to be applied in machinery. The nature of the new system of geering is best understood by comparing it with a system of friction wheels, such as are sometimes used for the transmission of motion. Let us suppose two such wheels in the same plane, touching at their convex edges. They are in contact only on a line equal to their common thickness, and would slide over each other without any resistance, if their surfaces were totally free from friction. In order that they should be capable of transmitting force, their surfaces must not only possess a certain degree of friction, but also must adhere with a normal pressure, the direction of which necessarily passes through their centres, thus throwing a considerable pressure upon their axes and gudgeons. This pressure is evidently diminished in a system of wedge and groove wheels, for the entire pressure at the surfaces of contact may be decomposed into two—one perpendicular to the axes, the other parallel to the axes. When the angle of the wedge is small, the former must be considerably less than the latter. Thus it appears that in the wedge system a part of the injurious pressure on the axes is not only removed but utilised. A series of experiments have been made by M. Minotto on the friction and adhesion at the edges of wedge and groove wheels of different dimensions and materials, a few of the principal results of which are appended in the following table. The pressures are given in kilogrammes, but the results are precisely the same if we suppose them changed to any other units of weight:—

| Conditions of Experiment. | Pressure of one wheel on the other. | Ratio of Friction at edges to the Pressure | Ratio of Adherence to the Pressure |
|---|---|---|---|
| *Angle of* 30°, *iron on iron*— | | | |
| Both wheels large ............ | 14·435 | 0·0237 | 0·440 |
| Small grooved wheel with large wedge wheel...... | 25·534 | 0·0300 | 0·501 |
| Ditto .................. | 47·514 | 0·220 | 0·596 |
| Small wedge wheel with large grooved wheel ... | 47·357 | 0·0255 | — |
| Ditto .................. | 96·257 | 0·0174 | — |
| *Angle of* 20°, *iron on iron*— | | | |
| Both wheels large ............ | 20·390 | 0·0140 | 0·720 |
| Both wheels small ............ | 40·000 | 0·0292 | 0·806 |
| Small wedge wheel with large grooved wheel ... | 34·290 | 0·0185 | 0·758 |

From these experiments it appears that the friction is greater

* From the 'Journal of Industrial Progress,' No. V.

† The views of M. Minotto were first published in Italian, at Turin, and attracted a great deal of attention last year on the Continent, having been examined or noticed in several scientific journals, and having been made the subject of a report to the Institute of France by M. Poncelet.

with small wheels than with large, and that it slightly diminishes in proportion to the increase of pressure. It deserves to be remarked, that in combination of two wheels, one large and the other small, the friction is less when the greater one is grooved and the small one wedged than in the opposite case. From a mean of all the experiments, the adhesion with an angle of 30° for the wedge is 0·529 of the pressure, and for an angle of 20°, 0·772.

Further experiments were made to ascertain the comparative friction of two plane surfaces and two surfaces shaped in the wedge form, the results of which confirm those previously made, and the ratio of the frictions of the two kinds of surfaces underwent scarcely any change by varying the charge or pressure—a result which does not seem to have been noticed by M. Minotto himself.

To compare the friction produced by the proposed method of geering with that of ordinary toothed wheels, M. Minotto has used the expression:—

$$f\,R\,\pi\left(\frac{1}{m}+\frac{1}{m'}\right),$$

$f$ being the coefficient of friction for the substance composing the teeth; R the force exercised by the wheels on each other; $\pi$ the ratio of the diameter to the circumference; $m$ and $m'$ the number of teeth in each wheel respectively. He gives an example of two wheels of cast-iron, one of ten, the other of twenty teeth, transmitting an effort say of 300 lb.; here $f = 0{\cdot}152$, and consequently the friction of the teeth is 21·45 lb. Two wheels on the wedge system, having to transmit the same force, would undergo an amount of friction measured by 9·081 lb., or less than half the friction with the system of teeth. Calculation would partly suggest the advantages of making the angle of the wedge small, not only to augment adhesion, but also to diminish the pressure and consequent friction on the axles.

Although this new system of geering possesses great simplicity and many other important advantages, it has to contend with some practical difficulties. It is essential that the edges of the wheels should be continually pressed against each other—a condition which becomes less and less possible as they wear away—and some contrivances are required to compensate for the gradual diminution of pressure. It is proposed that the gudgeons of one of the wheels should be made moveable, and capable of being screwed towards the axle of the other, or to have the grooved wheel consist of two discs, separated by a third capable of more or less compression, so that the two others could be brought together by screws as often as the wearing of the groove would require. The inventor also proposes in such cases as present a great likelihood of wear on the faces of wedge and groove, from the nature of the resistances to overcome—high velocity of motion and smallness of angle—that this effect could be obviated by indenting the edges of the wheels with two or more grooves and corresponding wedge-shaped projections. He concludes that the most suitable material for such wheels is cast-iron, next wrought-iron, or one wheel of brass and the other of cast-iron. He acknowledges that the system appears at present inapplicable to bevel wheels for the transmission of motion obliquely.

Wheels on the wedge-and-groove principle have undoubtedly the advantage of being easily constructed, of being free from jars and shocks, by which so much *vis viva* is lost in ordinary arrangements, and of being capable of easy engagement or disengagement during rapid motion. But yet much of the simplicity of the system is lost by the necessity of contrivances, such as have been mentioned, for the preservation of continuous pressure between the wheels at their edges. One important application will immediately suggest itself, as it did to us long before seeing the remarks of M. Minotto, or the confirmatory observations of M. Poncelet in his report to the Institute of France—namely, the haulage of railway trains up steep gradients. It is evident that this could be easily effected if the locomotive were provided with a wedged driving-wheel, placed centrally, which could run in a grooved rail extending the whole length of the gradient. This application would have the advantage of not requiring any contrivance for pressing the wedge into the groove, as the weight of the locomotive would do so most effectively, even for large angles of the wedge. Similar rails laid down near stations would furnish a method for stopping the train probably superior to the break now in use. Another important application is that of directly transmitting a rotatory motion to the great axles of screw steam-ships, the screws of which should revolve with considerable rapidity in order to produce a sufficient reaction on the exterior fluid. Quick motion might also be given to the driving-wheels of locomotives, without a rapid motion of the pistons, by the intermedium of some wheels on this system between the cranks and driving-wheels. The smoothness and equability of motion which ought to accompany all the movements of properly constructed wheels on the wedge system, suggest to us the importance of its application to clocks and chronometers, and to such astronomical and physical instruments as have hitherto been moved by the aid of toothed wheels or rack work. For such applications the angle of the wedge should be small, and every precaution taken to insure such an amount of adherence as would prevent any possibility of slipping. The facility of turning such wheels is so great, and so much is to be reasonably expected from their use, that we hope practical engineers and millwrights will soon bring the system to a final and complete test of its merits.

## ON THE STRENGTH OF LOCOMOTIVE BOILERS, AND THE CAUSES WHICH LEAD TO EXPLOSION.*

By William Fairbairn, F.R.S.

A difference of opinion having arisen between a gentleman high in authority and Mr. Fairbairn, concerning the causes of an accident which took place through the explosion of a locomotive engine at Manchester, on the eastern division of the London and North-Western Railway, a series of experiments was instituted by Mr. Fairbairn, not for the purpose of confuting the arguments of others or confirming his own, but to determine the real causes of the explosion, and to register the observed facts for our future guidance in guarding against such fearful catastrophes.

After a careful examination of the boiler a few hours subsequent to the explosion, one side of the fire-box was found completely severed from the body of the boiler, the interior copper box forced inwards upon the furnace; and with the exception of the cylindrical shell which covers the tubes, the whole of the engine was a complete wreck.

Mr. Ramsbottom, the Locomotive Superintendent, in his Report to the Directors, states that "the engine in question was made by Messrs. Sharp, Roberts and Co. in the year 1840, has been worked at a pressure of 60 lb. per square inch, and has run in all a distance of 104,723 miles, a great part of which has been either entirely without load, or nearly so. As the cylinders are only 13 inch diameter, it has been for some time too light to work any of our trains; and has therefore been chiefly employed since 1849 in piloting the trains through Standedge tunnel, along with another engine of the same size, which is now at work.

"The fire-box was originally $\frac{7}{16}$-inch thick, and is now a little over $\frac{6}{16}$-inch; and from its excellent condition, might well be supposed (as indeed it was by Mr. Sharp, of the firm of Sharp Brothers and Co., who inspected it a few days after the accident) to have been recently put in new. It is perfectly free from flaw or patch, and would certainly have run at least 100,000 miles. The same may also be said with respect to the outer shell, which is nearly of the original thickness. The engine had been in the repairing shop the three months previous to the accident; and the iron fire-box stays, about which so much has been said, were tested by the hammer in the usual way, and were considered, both by the workmen and the foreman, Wheatley, to be all sound. When originally made, they were $\frac{11}{16}$ths in diameter, and were equal to a strain of at least ten times the force they had to sustain. With the exception of one stay, which was on the top row, the one most reduced from oxidation was half-inch diameter; and supposing the hold on the copper box to have been good, it was capable of resisting a strain of rather more than $6\frac{1}{2}$ times the working pressure, equal, say, to 390 lb. per square inch. The only point therefore which could admit of doubt as to the safety of the boiler, was with respect to the hold which the stays might have in the copper box; but it appears, from experiments since made, and which have been repeated by Mr. Fairbairn, that from the force required to pull some of the old stays out of a copper plate similar to the fire-box, into which they had been screwed by the *old threads only*, and *not riveted*, the boiler could not have

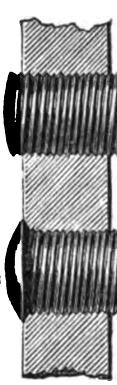
* Extracted, by permission, from the forthcoming Volume of the 'Transactions' of the British Association for the Advancement of Science.

burst under a pressure of less than 300 lb. per square inch. One of the old stays, which had had the thread partially damaged from being ripped out of the copper box by the explosion, was screwed by hand into a copper plate, by the old thread, to a depth equal to the thickness of the fire-box plate, but not riveted, and it required a dead weight of 8204 lb. to pull it out; and as each stay has to support a surface of 5 inches × 5⅜ inches, say 27 square inches only, it follows that a pressure of 8204 ÷ 27 = 303·85 lb. per square inch would have been required to strip it. Another stay, which had not been stripped by the explosion, but which was screwed out of the old box, was similarly treated, and required a force of 9·184 lb. to strip it, equal to 340 lb. per square inch."

Since the experiments here referred to were made, Mr. Fairbairn has repeated them with great care; and taking into account the tensile strength of the stays—in their corroded state—of the side of the fire-box, which to appearance was the first to give way, shows that a force of 380 lb. upon the square inch would be required to effect rupture; and the results of the experiments on the resistance of stays screwed into the copper fire-box fully confirm those already made by Mr. Ramsbottom. Assuming therefore that the ends of the screws were riveted, and sound in other respects, we may reasonably conclude that a strain not less than 450 to 500 lb. upon the square inch would be required to strip the screws, or tear the stays themselves asunder. These facts are founded upon the experiment of the resisting powers of the iron stay screwed into a portion of the copper cut out of the ruptured fire-box, and another experiment of a similar stay first screwed and then riveted, as shown in the annexed engraving.

The stay marked A, ¾-inch in diameter, in the first experiment required a force of 18,260 lb. = 8·1 tons to strip the screw, and draw it out of the copper; and the stay B, of exactly the same dimensions, but riveted over the end, required a force of 24,140 lb. = 10·7 tons before it was dislodged. Taking therefore the mean of those experiments, including those of Mr. Ramsbottom, and we arrive at the results given above,—namely, a resisting power of 785 lb. on the square inch, to burst or produce fracture in the stays and side of the fire-box.

A



B

Fig. 1.

In locomotive engines of more recent construction, where the stays are thicker and formed into squares of 4 to 4½ inches, the resisting powers wlll probably be increased to 850 or 900 lb. on the square inch, that is, seven or eight times the working pressure.

On a careful examination of the fire-box and every other part of the boiler, it was found that the stays and copper were perfect, and that they were able to sustain a pressure much exceeding 207 lb. upon the square inch, as given in the following table.

In these experiments, the top of the fire-box sank a little, owing to the breakage of a bolt of one of the cross-bars; but the fire-box stays were quite perfect, and to every appearance would have sustained nearly double that pressure. If the fire-box stays had been new and the top well-stayed, it is more than probable that a force from 800 to 900 lb. on the square inch would have been required to cause rupture.

As much stress has been laid upon the weakness of the stays which unites the flat surface of the boiler to the sides of the fire-box, the following experiments clearly indicate that the fire-box stays are not the weakest parts of a locomotive boiler, and that we have more to fear from the top of the furnace, which under severe pressure is almost invariably the first to give way. Great care should therefore be observed in the construction of this part, as the cross-beams should not only be strong, but the bolts by which the crown of the fire-box is suspended should also be of equal strength, in order that no discrepancy should exist, and that all the parts shauld be proportioned to a resisting force of at least 500 lb. on the square inch.

Finding the knowledge with regard to the power of resistance of locomotive boilers to strain exceedingly imperfect, Mr. Fairbairn availed himself of the present opportunity, to determine by actual experiment the laws on which these powers are founded; and for this purpose the Directors of the London and North-Western Railway Company placed in his hands an engine of the same age, constructed by the same makers, and in every respect a fac-simile of that which exploded. This engine was subjected to hydraulic pressure as follows:—

*Experiment made May 4th, 1853, to determine the Resisting Powers of the Fire-box and Exterior Shell of No. 2 Engine on the Eastern Division of the London and North-Western Railway.*

In this experiment, the boiler was furnished with a valve, 1 inch area, and a lever of suitable dimensions. This lever, 15 : 1, gave as the weight upon the valve 35 lb. and having suspended the scale, which indicated with the lever 50 lb., the following results were obtained:—

TABLE I.

| Number of pounds on scale. | Weights per sq. inch upon the valve. | Number of pounds on scale. | Weights per sq. inch upon the valve. |
|---|---|---|---|
| Lever ... | ... 35·0 [1] | 5½ ... | ... 132·5 |
| Scale ... | ... 50·0 | 6 ... | ... 140·0 [2] |
| ½ ... | ... 57·5 | 6½ ... | ... 147·5 |
| 1 ... | ... 65·0 | 7 ... | ... 155·0 |
| 1½ ... | ... 72·5 | 7½ ... | ... 162·5 |
| 2 ... | ... 80·0 | 8 ... | ... 170·0 [4] |
| 2½ ... | ... 87·5 | 8½ ... | ... 177·5 |
| 3 ... | ... 95·0 | 9 ... | ... 185·0 |
| 3½ ... | ... 102·5 | 9½ ... | ... 192·5 |
| 4 ... | ... 110·0 [3] | 10 ... | ... 200·5 |
| 4½ ... | ... 117·5 | 10½ ... | ... 207·5 [5] |
| 5 ... | ... 125·5 | | |

[1] This engine was the same age, and had run about the same number of miles as the exploded engine. The fire-box was considerably sunk or bulged, and the rivets as well as the stays much weakened. The engine had been at work since 1840.

[2] With this pressure a leakage was observed at some of the joints.

[3] Leakage increased.

[4] Leakage still increasing.

[5] With this pressure one of the bolts of the cross-bar over the fire-box broke, which caused the experiment to be discontinued, as the leakage was greater than the force-pump could supply.

From the above, it is evident that the boiler which led to these experiments could not have burst under a pressure of less than 300 to 350 lb. upon the square inch, as the failure of a single bolt in one of the cross-bearers above the fire-box, under a pressure of 207 lb. on the square inch, was not the measure of its strength, but one of those accidental circumstances which is calculated to weaken, but not absolutely destroy its ultimate powers of resistance. This conclusion was arrived at from the fact of finding the upper part of the fire-box in every respect perfect. After the removal of the pressure of 207 lb. on the square inch, and comparing these experiments with the appearance of the crown of the ruptured fire-box, Mr. Fairbairn is confirmed in the opinion that steam of high elastic force must have been present to cause the disastrous explosion which eventually occurred.

Again referring to the Report, Mr. Ramsbottom states,—"That it has been objected that the steam could not have been raised from 60 lb. per square inch, the pressure at which the safety-valve was blowing off before being screwed down, to the pressure stated by Mr. Fairbairn, in twenty-five minutes; but although I do not go all the way with Mr. Fairbairn as to the strength of the boiler, I find, from experiments made upon a boiler of somewhat similar dimensions, and placed as nearly as possible under the same circumstances, that the steam was raised from 30 lb. per square inch to 80 lb. as shown by Bourdon's steam-gauge according to the following scale, namely,—

| | h | m | s | | |
|---|---|---|---|---|---|
| Safety-valve screwed down | 3 | 1 | 20 | = | 30 lb. per square inch. |
| ... ... ... | 3 | 2 | 30 | = | 35 ... ... ... |
| ... ... ... | 3 | 3 | 45 | = | 40 ... ... ... |
| ... ... ... | 3 | 5 | 00 | = | 45 ... ... ... |
| ... ... ... | 3 | 6 | 15 | = | 50 ... ... ... |
| ... ... ... | 3 | 7 | 20 | = | 55 ... ... ... |
| ... ... ... | 3 | 8 | 30 | = | 60 ... ... ... |
| ... ... ... | 3 | 9 | 30 | = | 65 ... ... ... |
| ... ... ... | 3 | 10 | 30 | = | 70 ... ... ... |
| ... ... ... | 3 | 11 | 30 | = | 75 ... ... ... |
| ... ... ... | 3 | 12 | 20 | = | 80 ... ... ..." |

These experiments, although perfectly satisfactory as regards the time required to raise the steam (under ordinary circumstances of the engine, standing with the fire lighted, and the usual quantity of coke in the furnace) from 30 up to 80 lb. on the square inch—it was nevertheless considered desirable to repeat them through a still higher scale of pressure and temperature, and to ascertain, not only the exact time, but the ratio of increase, and the corresponding temperature of the steam in the boiler as the pressure progressively increased. For these objects, two delicately constructed thermometers were prepared by Dalgetti, and having adjusted Bourdon's pressure-gauge by a corresponding column of mercury, and an engine having been placed at Mr. Fairbairn's disposal, the following results were obtained:—

*Experiment made May 7th*, 1853, *to determine the rate of Increased Pressure, Temperature of Steam, &c. in a Locomotive Engine with the Safety-valve screwed down and the Fire under the Boiler.*

TABLE II.

| Time. | Pressure. | Temperature, No. 1 gauge. | Temperature, No. 2 gauge. | Mean Temperature. |
|---|---|---|---|---|
| h m | | ° | ° | ° |
| 2·44 | 11·75 | 243 | 243 | 243·00 |
| 2·45 | 14·15 | 247 | 246½ | 246·75 |
| 2·46 | 16·85 | 251 | 251 | 251·00 |
| 2·47 | 19·25 | 255½ | 255 | 255·25 |
| 2·48 | 22·85 | 260 | 259½ | 259·75 |
| 2·49 | 25·75 | 264 | 264 | 264·00 |
| 2·50 | 28·95 | 268¼ | 268½ | 268·37 |
| 2·51 | 32·15 | 273 | 273 | 273·00 |
| 2·52 | 35·75 | 277 | 277 | 277·00 |
| 2·53 | 39·95 | 282 | 282 | 282·00 |
| 2·54 | 44·25 | 286½ | 286¼ | 286·37 |
| 2·55 | 48·35 | 291 | 291 | 291·00 |
| 2·56 | 52·75 | 295½ | 295¼ | 295·37 |
| 2·57 | 57·75 | 300 | 300 | 300·00 |
| 2·58 | 63·75 | 304¼ | 304¼ | 304·25 |
| 2·59 | 68·95 | 308½ | 309 | 308·75 |
| 3·00 | 74·75 | 313 | 313 | 313·00 |
| 3·01 | 80·35 | 318 | 317½ | 317·75 |
| 3·02 | 87·25 | 322 | 322 | 322·00 |
| 3·03 | 93·95 | 326¼ | 326 | 326·12 |
| 3·04 | 101·15 | 331 | 331 | 331·00 |
| 3·05 | 108·75 | 335½ | 335¾ | 335·62 |
| 3·06 | 111·75 | — | — | —[1] |

[1] This experiment was lost, the thermometers not indicating a higher temperature.

Let us now endeavour from this table to discover the law expressing the relation between the time and pressure, or between the time and temperature.* The observations being made at intervals of one minute of time, and the furnace being maintained at the same intensity, it may be presumed that the quantity of heat communicated to the water was uniform, or that there were equal quantities of absolute heat communicated to the boiler in equal times. The column of pressures gives the successive augmentations of pressure at equal intervals, and the column of temperature gives the corresponding augmentations of heat as indicated by the thermometer. The column of pressures shows that the increments of pressure, in equal intervals of time, increase with the temperature; thus at or near 260° the average increment of pressure is at the rate of 3·1 lb. per minute; at or near 282°, it is 5·4 lb. per minute; at or near 326°, it is 7·1 lb. per minute. Mr. Ramsbottom's table of experiments indicates a similar result; thus at or near 268° the average increment of pressure is at the rate of 4 lb., whereas at or near 304° it is at the rate of 5 lb. per minute. The law, therefore, expressing the relation of time and pressure does not appear to admit of assuming a simple form. But the case is different with respect to the law expressing the relation of time and temperature. Thus if $T$ = temperature in degrees, and $t$ = the time in minutes at which this temperature is observed, estimated from the commencement of the experiments, then

$$T = a \times t + b \quad \text{.........................(1)}$$

will give the relation between $T$ and $t$ with great precision where $a$ and $b$ are constants, whose values, derived from these experiments, are $a = 4{\cdot}44$ and $b = -486$.

For example, let $t = 166$, then $T = 4{\cdot}44 \times 166 - 486 = 251°$, which exactly corresponds with the tabular value. Again, let $t = 180$, then $T = 4{\cdot}44 \times 180 - 486 = 313°{\cdot}2$; in this case the tabular value is 313°. Again, let $t = 185$, then $T = 4{\cdot}44 \times 185 - 486 = 335°{\cdot}4$; in this case the tabular value is 335°·6. From this formula we find

$$t = \frac{T + 486}{4{\cdot}44} \quad \text{.........................(2)}$$

If $t$ = the number of minutes which elapse between the temperatures $T$ and $T'$, then we find from 29 (1),

$$T' - T = 4{\cdot}44\, t' ; \quad \text{.........................(3)}$$

* The mathematical analysis of this question was supplied by Mr. Tate.

which shows that *the temperature increases with the time*; and presuming that the heat of the furnace remained constant, this formula also shows that *equal increments of absolute heat produce equal increments of sensible temperature as indicated by the thermometer.*

To determine the time, estimated from a given pressure, at which the boiler would burst,—

1st. Let the given pressure be that of the atmosphere, and let the boiler be able to sustain 240 lb. pressure per square inch. From an experimental table of pressures and temperatures, we find 240 lb. pressure to correspond to 403° temperature, and 15 lb. pressure to 212° temperature; hence we have by formula (3),

$$t' - = \frac{403 - 212}{4{\cdot}44} = 43 \text{ minutes},$$

which is the time in which the boiler would burst, estimated from the time at which the water begins to boil.

2nd. Let the given pressure be 60 lb. per square inch, and the boiler-pressure 240 lb. per square inch, then

$$t' = \frac{403 - 296}{4{\cdot}44} = 24{\cdot}1 \text{ minutes}.$$

3rd. Let the given pressure be 60 lb. per square inch, and the boiler-pressure 300 lb., then

$$t' = \frac{422 - 296}{4{\cdot}44} = 28 \text{ minutes},$$

which is nearly the time in which the boiler experimented upon would burst.

These facts appear to be sufficiently conclusive to enable us to judge of the dangers to which people expose themselves under circumstances where the necessary precautions are not taken for allowing the steam thus generated with the fire under the boiler to escape. The great majority of accidents of this kind have arisen during the time the engines are standing, probably with the safety-valve fastened and a brisk fire under the boiler. How very often do we find this to be the case in tracing the causes of these melancholy and unfortunate occurrences!

The statements contained in the earlier part of this paper regarding the strength of the stays of the fire-box would have been incomplete if we had not put those parts of a locomotive boiler, comprised in the flat surfaces or sides of a fire-box, to the test of experiment. This was done with more than ordinary care; and in order to attain conclusive results, two thin boxes, each 22 inches square and 3 inches deep, were constructed; the one corresponding in every respect to the sides of the fire-box, distance of the stays, &c., the same as those which composed the exploded boiler; and the other formed of the same thickness of plates, but different in the mode of staying, which, in place of being in squares of 5 inches asunder, as those contained in the boiler which burst, were inserted in squares of 4 inches asunder. The first contained sixteen squares of 25 inches area, representing the exploded boiler, or old construction; and the other, twenty-five square of 16 inches area, representing the new construction.

To the flat boxes thus constructed, the same lever, valve, and weight were attached as used in the previous experiments; and having applied the pumps of a hydraulic press, the following results were obtained:—

TABLE III.—*Experiment 1st.*—To determine the ultimate Strength of the Flat Surfaces of Locomotive Boilers when divided into squares of 25 inches area.

| No. of Experiment. | Pressure in lbs. per sq. inch. | Swelling of the sides, in inches. | No. of Experiment. | Pressure in lbs. per sq. inch. | Swelling of the sides, in inches. |
|---|---|---|---|---|---|
| 1[1] | 245 | + | 11 | 545 | ·05 |
| 2 | 275 | + | 12 | 575 | ·05 |
| 3 | 305 | + | 13 | 605 | ·06 |
| 4 | 335 | + | 14 | 635 | ·06 |
| 5 | 365 | + | 15 | 665 | ·06 |
| 6 | 395 | + | 16 | 695 | ·07 |
| 7 | 425 | + | 17 | 725 | ·07 |
| 8 | 455 | ·03 | 18 | 755 | ·07 |
| 9 | 485 | ·03 | 19 | 785 | ·08 |
| 10 | 515 | ·04 | 20 | 815 | —[2] |

[1] The box representing a portion of the flat surface of the side of the fire-box of a locomotive boiler was composed of a copper plate, on one side ½-inch thick, and an iron plate on the other ⅜-inch thick, being the same in every respect as the boiler which exploded.

[2] Burst by drawing the head of one of the stays through the copper, which from its ductility offered less resistance to pressure in that part where the stay was inserted.

The above experiments are at once conclusive as to the superior strength of the flat surfaces of a locomotive fire-box, as compared with the top, or even the cylindrical part of the boiler; but taking the next experiment, where the stays are closer together, or where the areas of the spaces are only 16 instead of 25 square inches, we have an enormous resisting power; a force much greater than anything that can possibly be attained, however good the construction, in any other part of the boiler.

TABLE IV.—*Experiment 2nd.*—To determine the ultimate Strength of the Flat Surfaces of Locomotive Boilers when divided into squares of 16 inches area.

| No. of Experiment. | Pressure in lbs. per sq. inch. | Swelling of the sides, in inches. | No. of Experiment. | Pressure in lbs. per sq. inch. | Swelling of the sides, in inches. |
|---|---|---|---|---|---|
| 1[1] | 245 | + | 25 | 965 | ·09 |
| 2 | 275 | + | 26 | 995[2] | + |
| 3 | 305 | + | 27 | 1025 | + |
| 4 | 335 | + | 28 | 1055 | + |
| 5 | 365 | + | 29 | 1085 | + |
| 6 | 395 | + | 30 | 1115 | + |
| 7 | 425 | + | 31 | 1145 | + |
| 8 | 455 | + | 32 | 1175 | + |
| 9 | 485 | + | 33 | 1205 | + |
| 10 | 515 | ·04 | 34 | 1235 | + |
| 11 | 545 | ·04 | 35 | 1265 | + |
| 12 | 575 | ·04 | 36 | 1295 | ·09 |
| 13 | 605 | ·06 | 37 | 1325 | ·09 |
| 14 | 635 | ·06 | 38 | 1355 | ·10 |
| 15 | 665 | ·07 | 39 | 1385 | ·11 |
| 16 | 695 | ·07 | 40 | 1415 | ·11 |
| 17 | 725 | ·07 | 41 | 1445 | ·12 |
| 18 | 755 | ·08 | 42 | 1475 | ·13 |
| 19 | 785 | ·08 | 43 | 1595 | ·14 |
| 20 | 815 | ·08 | 44 | 1535 | ·16 |
| 21 | 845 | ·08 | 45 | 1565 | ·22 |
| 22 | 875 | ·08 | 46 | 1595 | ·34 |
| 23 | 905 | ·08 | 47 | 1625 | —[3] |
| 24 | 935 | ·08 | | | |

[1] The flat box on which these experiments were made has the same thickness of plates as that experimented upon in the preceding table, viz., one side of copper ½-inch thick, and the other of iron ⅜-inch thick. The only difference between the two is the distance of the stays, the first being in squares of 25 inches area, and the other in squares of 16 inches area.

[2] From 995 to 1295 lb., the swelling or bulge on the side was inappreciable.

[3] Failed by one of the stays drawing through the iron plate after sustaining the pressure upwards of 1½ minute.

In the above experiments, it will be observed that the weakest part of the box was not in the copper, but in the iron plates, which gave way by stripping or tearing asunder the threads or screws in part of the iron plate at the end of the stay.

The mathematical theory would lead us to expect that the strength of the plates would be *inversely as the surfaces between the stays*; but a comparison of the results of these experiments shows that the strength decreases in a higher ratio than the increase of space between the stays. Thus according to the mathematical theory, we should have—

$$\text{Ult. strength 2nd plate per sq. in.} = \text{strength 1st plate} \times \tfrac{25}{16} = 815 \times \tfrac{25}{16} = 1273 \text{ lb.}$$

Now this plate sustained 1625 lb. per square inch, showing an excess of about one-fourth above that indicated by the law. This is in excess of the force required to strip the screw of a stay $\frac{11}{16}$-inch in diameter, such as those which formed the support of the flat surfaces in the exploded boiler.

It will be found that a close analogy exists throughout the whole experiments, as respects the strengths of the stays when screwed into the plates, whether of copper or iron; and that the riveting of the ends of the stays adds to their retaining powers an increased strength of nearly 14 per cent. to that which the simple screw affords. The difference between a fire-box stay when only screwed into the plate and when riveted at the ends is therefore in the ratio of 100 : 76, nearly the same as shown by experiment in the Appendix.

It is desirable, therefore, that we should ascertain the strain exerted on each stay or bolt of the fire-box. Let A, B, C, D, E, F, represent the ends of the bolt or stays; $O_1, O_2, O_3, O_4$, the centres of the squares formed by the bolts. Suppose a pressure to be applied at each of the points $O_1, O_2, O_3, O_4$, equal to the whole pressure on each of the squares, then the central bolt A, will sustain one-fourth of the pressure applied at $O_1$, also one-fourth of the pressure applied at $O_2$, and so on; so that the whole pressure on A, will be equal to the pressure applied to one of the square surfaces. Hence we have—

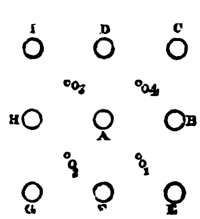


FIG. 2.

$$\text{Strain on the stay of Table III.} = \frac{815 \times 25}{2240} = 9 \text{ tons.}$$

$$\text{Strain on the stay of Table IV.} = \frac{1625 \times 16}{2240} = 11\tfrac{1}{2} \text{ tons nearly.}$$

The stay in the latter case was $\frac{11}{16}$-inch in diameter; hence the strain upon one square of section would be about 13 tons, which is considerably within the limits of rupture of wrought-iron under a tensile force.

In the experiments here referred to, it must be borne in mind that they were made on plates and stays at a temperature not exceeding 50° of Fah.; and the question naturally occurs, as to what would be the difference of strength under the influence of a greatly increased temperature in the water surrounding the fire-box, and that of the incandescent fuel acting upon the opposite surface of the plates.

This is a question not easily answered, as we have no experimental facts sufficiently accurate to refer to; and the difference of temperature of the furnace on one side, as compared with that of the water on the other, increases the difficulty, and renders any investigation exceedingly unsatisfactory. Judging, however, from practical experience and observation, Mr. Fairbairn is inclined to think that the strengths of the metals are not much deteriorated. His experiments on the effects of temperature on cast-iron do not indicate much loss of strength up to a temperature of 600°. Assuming therefore that copper and wrought-iron plates follow the same law, and taking into account the rapid conducting powers of the former, we may reasonably conclude that the resisting powers of the plates and stays of locomotive boilers are not seriously affected by the increased temperature to which they are subject in a regular course of working. This part of the subject is, however, entitled to future consideration; and it may be hoped that some of our able and intelligent superintendents will institute further inquiries into a question which involves considerations of some importance to the public, as well as to the advancement of our knowledge in practical science.

## APPENDIX.

In order to test with accuracy the tensile power of the different descriptions of stays used in locomotive boilers, and to effect a comparison between those screwed into the plates and those both screwed and riveted, it was deemed expedient to repeat Mr. Ramsbottom's experiments on a larger scale; and by extending the tests to copper stays as well as iron ones, it was considered that no doubt could exist as to the ultimate strength of those simply screwed, the tensile powers of the stays themselves, and the relative difference between those and the finished stays when screwed and riveted on both sides of the fire-box. The large lever and requisite apparatus being at hand, the experiments proceeded as follows:—

*Experiments to determine the Ultimate Strength of Iron and Copper Stays generally used in uniting the flat surfaces of Locomotive Boilers.*

*Experiment* I.—Iron stay ¾-inch diameter, screwed into a copper plate ⅜-inch thick (as fig. 3).

| No. of Experiment. | Weight in lbs. | No. of Experiment. | Weight in lbs. |
|---|---|---|---|
| 1 | 9,860 | 4 | 14,900 |
| 2 | 11,540 | 5 | 16,580 |
| 3 | 13,220 | 6 | 18,260[1] |

[1] With the last weight, 18,260 lb. = 8·1 tons, the threads in the copper plate were drawn out or stripped after sustaining the weight a few seconds.

*Experiment* II.—Iron stay ¾-inch diameter, screwed and riveted into a copper plate ⅜-inch thick (as fig. 4)

| No. of Experiment. | Weight in lbs. | No. of Experiment. | Weight in lbs. |
|---|---|---|---|
| 1 | 9,860 | 6 | 18,260 |
| 2 | 11,540 | 7 | 19,940 |
| 3 | 13,220 | 8 | 21,620 |
| 4 | 14,900 | 9 | 23,300 |
| 5 | 16,580 | 10 | 24,140[1] |

[1] When the last weight, 24,140 lb. = 10·7 tons, was laid on, the head of the rivet was torn off: and the stay, along with the threads in the copper, was drawn through the plate.

*Experiment* III.—Iron stay ⅞-inch diameter, screwed and riveted into an iron plate ⅜-inch thick (as fig. 4).

| No. of Experiment. | Weight in lbs. | No. of Experiment. | Weight in lbs. |
|---|---|---|---|
| 1 | 9,860 | 6 | 23,300 |
| 2 | 13,220 | 7 | 25,980 |
| 3 | 16,580 | 8 | 26,660 |
| 4 | 19,140 | 9 | 27,940 |
| 5 | 20,780 | 10 | 28,760 [1] |

[1] With the last weight, 28,760 lb. = 12·5 tons, the stay was torn asunder through the middle, both screw and plate remaining perfect.

*Experiment* IV.—Copper stay ⅞-inch diameter, screwed and riveted into a copper plate ⅜-inch thick (as fig. 4).

| No. of Experiment. | Weight in lbs. | No. of Experiment. | Weight in lbs. |
|---|---|---|---|
| 1 | 9,860 | 4 | 14,900 [2] |
| 2 | 11,540 [1] | 5 | 16,265 [3] |
| 3 | 13,220 | | |

[1] With 11·540 lb. the body of the stay was slightly elongated.
[2] Elongation considerably increased with 14,900 lb.
[3] Broke with 16,265 lb. = 7·2 tons, after sustaining the load upwards of three minutes. The ultmate elongation was 0·56 inch in a length of 3 inches.

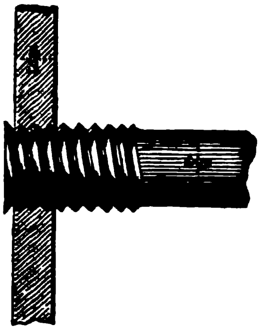


Fig. 3.

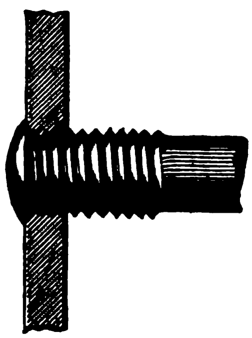


Fig. 4.

It will be observed, on comparing the results obtained from the above experiments, that iron plates and iron stays are considerably stronger than those made of copper. It may not be advisable to have the interior fire-box made of iron, on account of its inferior conducting powers and its probable durability; but so far as regards strength, it is infinitely superior to that of copper, as may be seen by the following

*Summary of Results.*

| No. of Experiment. | Breaking weight in tons. | Resistance per sq. inch in tons. | Ratio, Exp. III., the iron stay and iron plate taken as 1000. | |
|---|---|---|---|---|
| III. | 12·5 | 27·7 | 1000 : 1000 | Iron and iron. |
| I. | 8·1 | 18·8 | 1000 : 648 | Iron and copper screwed only. |
| II. | 10·7 | 23·6 | 1000 : 856 | Iron and copper screwed and riveted. |
| IV. | 7·2 | 16·1 | 1000 : 576 | Copper and copper screwed and riveted. |

On the above data, it will be found that the iron stay and copper plate (not riveted) have little more than one-half the strength of those where both are of iron; that iron stays screwed and riveted into iron plates are to iron stays screwed and riveted into copper plates as 1000 : 856; and that copper stays screwed and riveted into copper plates of the same dimensions, have only about one-half the strength of those where both the stays and plates are of iron. These are facts in connection with the construction of locomotive, marine, and other description of boilers having flat surfaces, which may safely be relied upon, and that more particularly when exposed to severe strain, or the elastic force of high-pressure steam.

*Royal Institute of British Architects.*—At the annual general meeting of the Institute, held on the 1st of May, the following officers were elected for the ensuing year:—President: Earl de Grey. Vice-Presidents: Messrs. T. H. Wyatt, B. Ferrey, and F. C. Penrose. Honorary Secretaries: Messrs. J. J. Scoles and C. Nelson. Ditto for Foreign Correspondence: Mr. T. L. Donaldson. Members of Council: Messrs. H. Ashton, J. Bell, M.P.; J. H. Good, jun., R. C. Hussey, G. Mair, E. Christian, H. Clutton, J. H. Hakewill, G. O. Leicester, and P. C. Hardwick. Auditors: Messrs. T. H. Lewis, fellow; and W. A. Buckley, associate.

## DRAINAGE OF THE DISTRICTS NORTH OF THE THAMES.

We last month gave the joint report of Messrs. Bazalgette and Haywood, and that of Sir William Cubitt, on the proposed plan for the drainage of the districts lying north of the Thames. The report of Sir Robert Stephenson, on the same subject, which is given below, has been subsequently received by the Metropolitan Commissioners of Sewers, and was read at a special meeting held on the 16th ult:—

Gentlemen—Absence from England prevented my uniting with Sir William Cubitt in drawing up his remarks, dated February 25, 1854, on the joint Report of Messrs. Bazalgette and Haywood, on a proposed system of intercepting drains throughout that portion of the metropolis lying on the north side of the river Thames. I therefore now take leave to lay before you a few observations on that Report, and before doing so may premise that it is not my intention to revert to those points touched upon by Sir William Cubitt, as I entirely concur in the opinion he has given respecting the general merits of the plan and the estimated cost of carrying it out. My observations will rather have reference to the general principle of intercepting sewers upon which the design is based, and to one or two of the localities where it has been deemed advisable to depart from this system to meet special conditions.

With respect, then, to the application of the principle of intercepting sewers to very large towns, and more especially to the metropolis, where it has become imperative to lessen, as far as practicable, the nuisance of discharging the sewage directly into that part of the Thames upon which the metropolis is situate, I believe there is considerable unanimity of opinion among engineers who have been called upon to direct their attention to the subject. When I was a member of your body it fell to my lot to examine upwards of 150 suggestions for improving the drainage of London, among which were many from professional men of experience, and by far the majority of these, when a comprehensive study of the subject had been made, agreed on adopting a series of intercepting sewers, as the only method affording a simple and efficient system of drainage, and at the same time freeing the Thames through London of pollution.

The plan which was afterwards submitted by Mr. Frank Forster to the Commissioners may be regarded as embodying most of the useful views which such of the plans contained as were based upon the principle of interception by main lines of sewer, carried to a point on the river so far down as to prevent the reaction of the tidal waters bringing the feculent matter back among the inhabitants of the metropolis.

The design now produced by Mr Bazalgette and Mr. Haywood may be regarded as the extension of Mr. Forster's views, adapted to the new features which every suburb of London is yearly presenting. They have also made some judicious modifications suggested by time and further information, one of the most important of which is the removal of the lowest intercepting drain from the shore of the river, as such a position, although chosen for the purpose of making the system of interception complete, would have been carried out with the utmost difficulty, in consequence of the loose nature of the soil, and at a cost incapable of any certain calculation beforehand.

The construction of this low-level intercepting sewer does not, however, press for immediate attention, for it is clear, that of the three intercepting sewers comprehended in Messrs. Bazalgette and Haywood's plan, the construction of the upper and middle levels should be proceeded with first. Their completion alone will greatly relieve the Thames of impurities by lessening the direct discharge, will render the construction of the lowest level less difficult and less costly. Indeed, it is not improbable, that by the diversion of so large a portion of the sewage matter from the river as would be under the control of the middle and upper lines of interception, the formation of the lowest would become comparatively much less important, and might be postponed for some length of time, and so relieve the demand upon those who supply the funds.

The two upper lines of interception would in fact leave less offensive matter to be discharged into the sewers than has taken place in any time within living recollection. It is the only mode of procedure which seems adapted eventually to remove, and at once to mitigate, many of the chief difficulties and annoyances attaching themselves to this complicated question.

In this design, the system of interception is applied to the whole of the metropolis on the north side of the river, excepting a portion which is designated the western district, comprising an area of about eighteen square miles, commencing a little to the east of Brompton and Chelsea, and extending westward as far as Brentford. The level of all this district is so low, that it is impossible to obtain any other natural means of drainage than into the river, as at present. To obviate this objection, it is proposed to treat the western district by a different method, which appears to me well calculated to overcome the obstacles arising out of this circumstance, namely, to direct the whole of the sewage to one point on the shore of the river near the entrance into Kensington Canal, and there take means for separating the liquid and solid portion of the sewage before the former is discharged into the river. Experiments on a large scale with this process are now being made, and with such result that its ultimate success may be fairly deemed probable.

I agrée therefore with the recommendations made in this Report as to the method to be applied to the western district, in consequence of its extremely low level.

With the general lines of direction which have been selected for interception I also concur; but, in anticipation of the success of the method for extracting solid manure from the sewage, and its becoming remunerative, it is suggested, "that considerations may arise seriously affecting the scheme proposed," and a question is raised, "whether it would not then be advisable, on the score of economy, to modify the designs presented for the middle and low-level sewers, and to abandon the chief portion of the line between the river Lea and Barking Creek." In this I do not go to the full extent with Messrs. Bazalgette and Haywood, for, although the process for the manufacture of manure may prove successful, I do not think this probably would tend to, still less would justify, the delay of the construction of the middle-level works. These seem to me to be absolutely necessary to rectify the present defective system of drainage, whatever shape the manure question may eventually take. I have already stated that the middle-level is calculated, when properly dealt with, to ameliorate the evils so much complained of in so marked a manner, that the execution of the lower level may perhaps safely be postponed for a time; but I can foresee no degree of improvement in the manufacture of manure in prospect that would tend to any material alteration in its construction, or position, or cost. It strikes at the root of many of the existing evils in the most direct manner, while it comprehends within its scope and influence so large and important a district that I think no minor obstacle ought to stand in the way of its execution, The extension to Barking might, I think, be dispensed with, as suggested.

If in extending and perfecting the drainage of London, the chief objects be the improvement of the general sanitary condition of the inhabitants, and the purification of the Thames from noisome matter, I cannot help repeating that I regard the middle intercepting sewer as one of the most important features of the scheme on which I am now reporting, and, indeed, without it either object, and the last especially, could only be very partially attained, for no arrangement in the extraction of the solid matter from the sewage, that I can conceive, would prevent the frequent discharge of the usual amount of noxious filth into the river.

This can only, I believe, be avoided by the intercepting system being fully carried out, and no part of the proposed plan is more effective than the middle interception, and none can be so ill spared or postponed.

I am induced to express this opinion somewhat decidedly, because, having had my attention called to several methods that have been proposed for the extraction of manure from sewage, I have been led to the conclusion, that, instead of multiplying such establishments within the precincts of towns, as some contemplate, a complete system of interception, with the concentration of the manure process on a few points, is that which is best calculated to attain success.

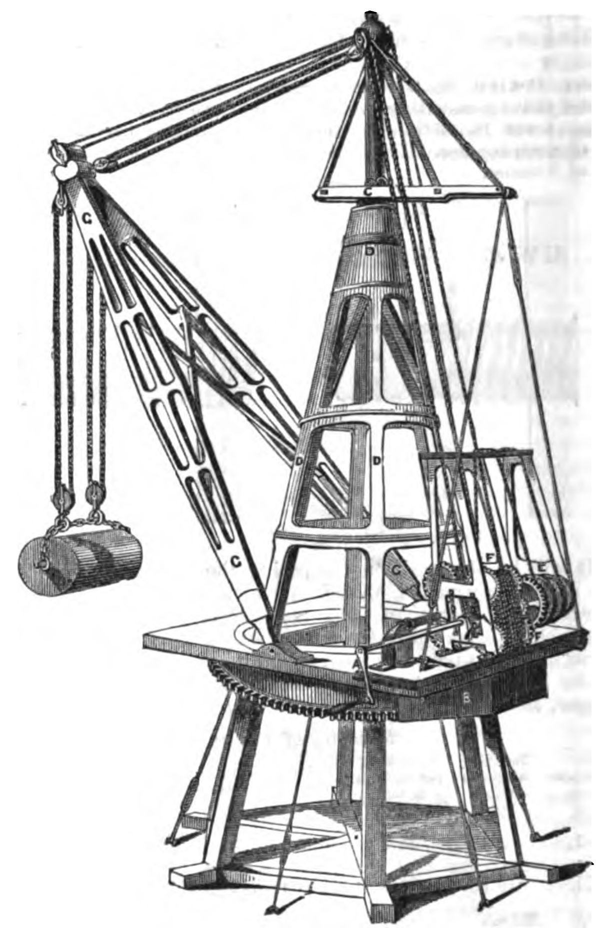
With reference to the dimensions of the proposed sewers, I have not been able to go into the details of the calculations, but having examined the tabular statements attached to the Engineers' Report, and having received explanations from them respecting the directions of the flow in the various sewers intended to take place, I have every confidence in the correctness of their conclusions.

I have only further to add, that I regard the design of Messrs. Bazalgette and Haywood as comprehending, in a very practical shape, all the essentially useful suggestions which have from time to time been made by engineers respecting the drainage of the metropolis; and I have no doubt whatever, that if the Commissioners be put in a position to carry it out, it will be found effective. I am, &c.,

*24, Gt. George-street, Westminster,* ROBERT STEPHENSON.
*May 15th*, 1854.

## PATENT IMPROVED DERRICK.*

JOHN B. HOLMES, U.S., *Patentee*, February, 1854.



THE main part of this derrick consists of an upright frame *d*, placed on a revolving platform B, on which is fixed a boom *g*, with two arms, the jointed heels of which are secured in the platform between the central upright frame and the horizontal capstans. On the top of the frame is a revolving cap *c*, with the mast secured on it. *f*, are double capstans; and *e*, are reels for taking up the the slack of the ropes; *a*, is the crank for working the whole machinery. This derrick can be worked by hand, horse, or steam power. A pinion gears into the large wheel of platform B, and moves it round as desired; it can be thrown out of gear when required. The boom *g*, can be elevated along with the weight to be raised, or it can be held stationary when the weight is being lifted, or it can be raised and the weight held at any position—neither raised nor lowered. One capstan is for working the boom *g*, and the other for working the lifting block and tackle. The boom is suspended from the top of the revolving cap, the latter being held down by tension rods on the other side. The platform B, is held down by a collar, which is sustained by the vertical under tension-rods. As the platform B, is thus constructed and arranged in connection with the revolving cap *c*, a very light mast can be employed, and the use of guys, connected with anchors (in the usual way), is obviated.

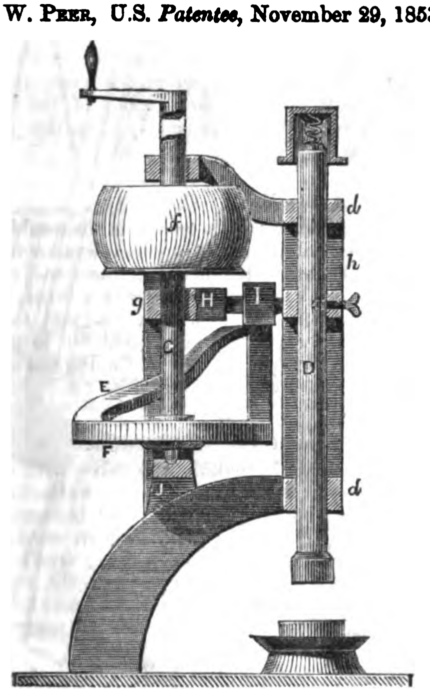
There are two falls for hoisting, shown on the end of the boom;

* From the 'Scientific American.'

both ropes are wound up at the same time on the capstan, and all the slack is carried over small pulleys, and wound up on one reel *e*; the other reel takes up the slack of the boom ropes. It will be observed that there are four ropes passing from the cap; the one at each side for working the falls that lift the weight, and the two inside ones for working the jointed boom *g*. The weight can be brought in and out on a level, or hoisted above or below a level, with the platform. The cap and boom can be carried round the circle together, and by placing the working machinery, capstans, &c., opposite to the weight to be hoisted, they form a counterbalance to that weight on the platform. Two coils of rope will be observed on the two horizontal capstans, which worked by the main shaft of *a*, are capable of being thrown in and out of gear with that shaft, to work either capstan and reel, singly or altogether, as required. They are also geared for a fast or slow motion, for light and heavy hoisting. It will be observed that by elevating the boom, the circle described by the hoisting lever can either be increased or diminished—a very important arrangement.

## TRIP HAMMER.

J. W. Peer, U.S. *Patentee*, November 29, 1853.



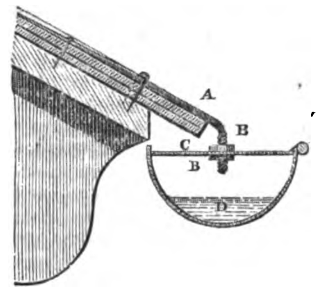

The nature of this invention consists in raising and lowering the hammer by means of a screw-cam arranged upon a circular plate, secured fast on a revolving shaft, and connected to the helve of the hammer by means of a horizontal lifting-arm, which has one of its ends attached fast to the hammer by set-screws, and its other end sliding freely up and down over the vertical cam-shaft as the hammer rises and falls, the said arm carrying a small friction-roller, which, as the cam-shaft revolves, turns freely and plays upon the top of the screw-cam, and prevents friction from the weight of the hammer upon the cam, as it is gradually raised by the cam. This invention further consists in arranging the screw-cam upon an adjustable frame, so that it may be adjusted to any position desired, and the length of the blow to be given to the hammer regulated so that if a full or half blow be required they may be secured

The annexed engraving represents an elevation, partly in section, of this machine. D, is the hammer moving up and down in guides *d*, *d*; E, the screw-cam secured to the plate F, and extending more than half round it. The plate F, is secured to a revolving shaft G, the lower end of which rests on a table J, which can be raised or lowered by means of two set-screws one of them in front and the other in rear of the shaft G; *f*, is the driving-pulley. The shaft G, is connected to the hammer D, by means of the arm H, with its two collars *g*, and *h*; the collar *g*, slides freely over the shaft G; and the collar *h*, is fastened to the hammer; I, is the friction-roller.

## SUSPENDING EAVES' TROUGHS.

Chauncey D. Woodruff, *Patentee.*

The annexed engraving represents a transverse section of an improved method of suspending and fastening eaves-troughs. A, is an iron rod, fitted with screw and nuts B, at its lower end, and secured to the rafters by staples and nails. D, is a cross-bar soldered to the eaves-trough, of sufficient strength to keep the trough in shape and sustain its weight. The screw and nuts on the rod A, allow of the trough being elevated and lowered as required.

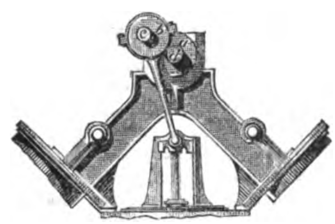



This invention gets rid of the unsightly straps and rails which at present disfigure the cornices of buildings.

## AIR-PUMPS OF STEAM-ENGINES.

Douglas Hebson, *Patentee*, April 13, 1853.

This invention consists in causing the main driving-crank of this engine to be made so as to form an eccentric, from which motion is conveyed to work the air-pump by connecting the eccentric band or hoop to the air-pump rod. The annexed engraving represents a front elevation of the driving-crank and

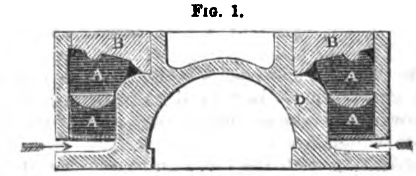


crank-pin, with inverted eccentric on the same for working the air-pump. *a a*, is the centre portion or boss of the main driving-crank; *b b*, the eccentric for working the pumps; *c*, the crank-pin, to which motion is given by the engine; *d*, the crank-shaft. The eccentric *b b*, may be made solid or in one piece, either with the crank or crank-pin or in a separate piece, properly secured to the crank-pin. Or, instead of the above arrangement, the crank itself may be made to work as an eccentric, whilst the eccentric strap conveys motion to the air-pump.

## STEAM SLIDE-VALVES.

E. T. Rees, *Patentee*, February 8, 1854.

Fig. 1.



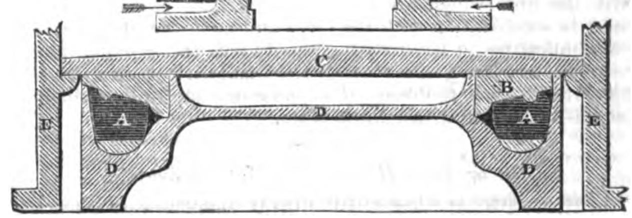




Fig. 2.

Fig. 1 of the above engravings represents a transverse section, and fig. 2 a longitudinal section of this improved slide-valve for steam-engines. A, A, are portions of vulcanised india-rubber, let into a mortice or channel in the valve-casting, and covered by a metallic cover B; C, is the back plate of the valve-casing; D, the valve; and E, the steam-chest. By the elasticity of the india-rubber, and the pressure of steam which is admitted at the sides of the valve, the plate is kept steam-tight against the steam-chest cover or plate, secured in the steam-chest.

## RECENT AMERICAN PATENTS.

[Reported in the Journal of the Franklin Institute.]

*Rotary Engines.* E. Barrows.

*Claims.*—1. The revolving steam-wheel, having projecting rims or flanges, revolving within the interior of a stationary cylinder, in which are two or more fixed abutments or stops, which fit steam-tight, so as to close and divide the annular space between the cylinder and wheel, into two or more steam-chambers; the said steam-wheel having four or more pistons whose operation is controlled by a stationary curved groove or way in each cylinder-head, so as to be alternately acted upon by the steam in the cylinder, and down within the wheel, so as to pass and clear the abutments or stops; 2. The six way-cocks or steam-heads, having each a steam-passage leading to its plug-seat, two steam-passages leading from the plug-seat to opposite chambers of the cylinder, two exhaust-passages leading from opposite chambers of the cylinder back to the plug-seat, and one leading from the plug-seat to the exhaust-pipe, their cock-plugs being provided with suitable openings and passages to make communication to or from the steam and exhaust pipes to either division of the cylinder, or to close both; 3. The mode of uniting the face and side packing-pieces of the pistons and abutments, so as to make them steam-tight at their corners by dovetailing them. The patentee further claims making the steam cylinder within and a part of the piston-wheel, the stationary rim forming the outer side of said cylinder, so that three sides of the said cylinder shall revolve with the pistons.

*Ruling Paper.* J. and W. McAdams.

*Claims.*—1. A machine for ruling paper, in which both the horizontal and vertical lines of the sheet are ruled in passing once through the machine, by any arrangement of devices which carries the sheet, after one set of lines is ruled, in a direction at right angles to its first course, to another set of pens, which rule the sheet across the lines first made; 2. Changing the direction of the movement of the sheet after passing from the first set of pens, by means of the travelling-band and revolving-drums; 3. Lifting the pens so as to leave a heading to the sheet, by means of the roller with its moveable tongue and cam projection, acted upon by the edge of the paper and the motion of the feed-roll, so as to lift an adjustable arm connected to the pen-holder; 4. Forming grooves in the feed-rolls so that the pens may rest over these grooves, and not upon the rolls between the passage of the different sheets; 5. Guiding the sheet straight to the second set of pens, after the direction of its movement is changed, by means of the converging bands, which carry the edge of the sheet against a proper guide, or against the side framework of the machine; 6. Forming the last roll which carries the sheet after it is ruled to the receiver of a polygonal or angular shape, so that its revolution may give a vibratory motion to the sheet.

*Making Nuts.* J. Reese.

*Claims.*—1. The use of the trough of cold water, in combination with the rotating die-box, for the purpose of cooling each die or mould after it has discharged its nut, and preventing the water from coming in contact with other parts of the machine, or with the nuts which are made in it; 2. The use of the guide-head, in combination with the lever and guide, for the purpose of communicating to the rotating mould-box the peculiar motion required, consisting of a succession of sudden yet steady quarter revolutions, each followed by a pause or rest, during which the mould-box is held firmly in its place.

*Bit or Drill Holders.* D. H. Chamberlain.

*Claim.*—There is a hand-drill already constructed so as to have its drill-shaft supported in a stock, and rotated by means of two bevilled gears, one of them being fastened on the top of the drill, while the other was affixed on a separate shaft, disposed at right angles with the drill-shaft, and having the crank applied so as to enable a person to rotate it, and thereby put the drill-shaft in rotation. In the said drill-stock, the crank of it is made to rotate in a plane parallel to the axis of the drill-shaft; the consequence is, that during a rotation of the crank there is an uneven pressure exerted on the drill, the said pressure being increased at one moment and diminished at another, and in the direction of the axis of the drill. A steady pressure on the drill, longitudinally as well as laterally, is desirable, particularly when a small drill is used, as without it the drill is not only liable to be broken or injured, but to be made to deviate in its desired course in passing through anything. The complication of the construction of the bevilled gear bit-stock, and the disadvantages incident to it while in use, render it an instrument of little value and utility. The inventor lays no claim to the above arrangement, nor the method of making the tool-stock and the bell-crank in one piece of metal, so that their rotations may be equal and simultaneous; but what he does claim is, the arrangement of the bell-crank separate from and so as to play or rotate within the tool shaft stock, the said bell-crank having a spur gear to work into a pinion fixed into the end of the tool-shaft, and to impart to said tool-shaft an accelerated motion.

*Tool Holders.* D. H. Chamberlain.

The inventor does not claim a split or jaw socket having a screw and screw-nut applied to it for the closing its jaws upon the shank of an awl or tool inserted between them; but the method of arranging, constructing, and applying together the jaws and confining screws, the same consisting in making the jaws separate from the screw-shank on which the screw is cut; and not only providing the screw-nut with a closing concavity or socket, but the screw-shank with a closing socket for the jaws to rest in, the whole being so that when the screw-nut is screwed down upon the jaws, the combined action of the jaws and the screw-nut shall operate to simultaneously close the jaws at their upper and lower ends.

*Lime Kilns.* C. D. Page.

*Claim.*—The form of the stack or cupola, in combination with the arrangement of flues from the fire-chambers for the introduction of the products of combustion at the lower end, to insure the burning of the central part of the charge. Also, cooling the calcined lime preparatory to drawing it out and exposing it to the atmosphere by causing a current of cold air to pass through the saddle, or its equivalent, placed at the bottom of the stack, and on to which the calcined lime descends.

*Valve Cocks.* J. Griffiths.

This invention consists in making the valve with a cylindrical stem, passing through a hollow stem, which is attached rigidly to or forms part of the body of the cock, and is furnished outside with a screw, to which is fitted a nut, which carries a yoke, in which the valve-stem is capable of turning freely, but not of moving longitudinally. By turning the nut the valve is raised and lowered from and to its seat in a right line, the valve being always kept in such position that it will fall truly into its seat and close tightly.

*Claim.*—The combination of the hollow fixed stem, the solid stem, and the yoked nut.

*Fire and Burglar Proof Safes.* F. C. Goffin.

This invention consists in filling the space between the two casings of a safe or vault door with glass or slag, when in a vitrified state, for the purpose of rendering the safe or door fireproof, and also proof against the efforts of burglars, glass being a poor conductor of heat, and so hard as to effectually prevent the operation of boring or drilling through the sides of the safe or door.

*Turning Lathes.* E. Bancroft and W. Sellers.

*Claim.*—The method of varying the motions of the mandril, and screws or leader, by means of the two series of wheels, each series consisting of wheels of different diameters, and all the wheels of one series being connected and turning together, and imparting motion to all the wheels of the second series, with different degrees of velocity, when this is combined with the method of locking any one of the wheels of the second series with the shaft of the screw or leader, by having the wheels on separate sleeve-arbors, fitted to turn on each other, and adapted to receive a locking pin or bolt, fitted to holes in a plate attached to the shaft of the screw. Also, the manner of supporting and sustaining the screw or leader by combining therewith a trough, having the outer end of the said screw or leader without a journal.

*Fire-Arms.* T. Cook.

*Claims.*—1. Cutting slots in the tubes of the magazine, and with each tube a spring connected with a ring moving on the outside, for feeding up the spring and maintaining the compressed position given at the time of charging the tubes with ammunition, whereby such charge can be forced into the conveyor by power independent of gravity, whether the feed-ring be combined with a screw exteriorly placed, or within the interior of the cluster of tubes, or whether the same effect be produced by any manner analogous; 2. Combining the tube-magazine with the conveyor, in such manner that it will be revolved so as to bring each tube of the series successively opposite to the hole through which the charge is fed to the conveyor, whenever and so often as a charge has been transferred to the barrel; 3. The follower in combination with the cavity of the conveyor, and the lever for ejecting the charge into the barrel; 4. The cam-groove in combination with the finger-levers, and the cap-case to regulate the feed.

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*Ploughs.* J. S. Neall.

This invention consists in fixing the mould-boards of either single or double ploughs on hinges, so as to be capable of being adjusted to any required width of furrow or crop to be cultivated, in so attaching the beam to the body of the plough by means of screw-bolts that the point of the beam can be raised or lowered at pleasure with great precision, so as to cut any required depth of furrow, in the manner of giving a nice lateral adjustment to the end of the beam by means of a set screw, so as to regulate the angle of the plough with the line of draught, in such way as to give land to the plough or take it from it, and also in the mode of raising or lowering the points of draught of the plough, without altering the position of the beam.

*Claim.*—The hinges, constructed in such a way that the edge of the front part of the mould-board may lap over the edge of the back part or wing of the mould-board, to prevent clogging.

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*Dies for Making Seamless Metal Tubes.* T. D. Jackson.

*Claim.*—A die for drawing seamless metal tubes, constructed with an eye, whose periphery is formed of a series of narrow friction-rolls, which produces a substantially equable extension of every part of the circumference of the tube being drawn.

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*Snow-Ploughs for Railroads.* A. Hall and S. Sturtevant.

*Claim.*—So shaping, proportioning, and placing the notched shares of the snow-ploughs that they will extend down within the inner sides of the rails nearly to the cross-ties, without coming in contact with the chairs, for the purpose of removing snow and ice from the immediate vicinity of the inner sides of the rails, and, by means of their mould-boards, discharging the same at a proper distance outside of the rails.

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*Controlling the Pressure of Steam.* H. S. Williams.

*Claims.*—1. Opening the water-cock of the steam-boiler for the purpose of letting on water for reducing the temperature and pressure of the steam, and thereby preventing explosions, by means of a plunger and slotted arm, and operated, when the supply should be let on, by the pressure of the escape steam of the safety-valve, and by means of a spring attached to the boiler and slotted arm, when the supply is being shut off; 2. Starting the steam-pump or "doctor" running, in case it should not be in operation when the pressure of the steam in the boiler rises above the given point, by means of the escape steam from the safety-valve, when admitted to the steam-chest of the pump through a branch pipe of that carrying the plunger, the said branch pipe being provided with a valve, which prevents the steam from the doctor passing into the boiler when the pump is running, but allows of the steam being admitted to the steam-chest when the pump is not running.

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*Fusible Discs in Steam-Boilers.* W. Burnett and J. Absterdam.

The nature of this invention consists in inserting in a steam-boiler, at a point below the proper water-line, and above all the heating surfaces, a pipe, which, at a suitable distance from the said boiler, is stopped up by a plate of fusible metal or other fusible compound, it being so arranged, that by freely exposing the said pipe to the atmosphere, the water contained therein shall have its temperature so far reduced by radiation as to preserve in a solid state a fusible metal that will be easily melted by the temperature of the steam in the boiler when the water-level shall have fallen so low as to admit steam into the pipe.

*Claim.*—Placing in a pipe which is connected with a steam-boiler a fusible plug or disc, the said plug or disc being so far removed from the boiler, but so connected with the water therein, that when the water is sufficiently high, the plug or disc will be in contact or so surrounded with water cooler than that in the boiler as to prevent it from being fused; but when the water in the boiler shall fall below a proper height, the steam will enter and come in contact with the plug, or so surround it as to cause it to melt.

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*Corrugating Metal Plates.* R. Montgomery.

This invention consists in passing a plate a number of times through a pair of grooved rolls and a stationary crimping die, by which the folds of the beam are gradually brought to the proper depth without endangering the rupture of the metal, which is unavoidable when the corrugation of folds of any considerable depth is effected by rollers alone.

*Claim.*—The method of forming corrugated metal beams by passing a plate of metal of the proper size through a series of grooves between rolls, and through a series of crimping dies.

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*Quartz Crushers.* S. W. Bullock.

*Claim.*—The application of gear-wheels, solely for the purpose of causing the crushing-wheels to turn on their axis faster (or make more revolutions) than they otherwise would in rolling around in the trough, the point of contact (or pitch-line) of said gear-wheels being on a line drawn from their common centre to a point upon the crushing-wheels within its outer diameter or periphery, thereby giving the periphery a slip or sliding motion upon the quartz.

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*Railroad Chair Machines.* M. M. Gray.

This invention consists in the manner of causing a series of punches, knives, and dies, and a former and its base, to operate upon a heated plate of malleable iron, so as to pierce, cut, and compress the same into the form of a railway-chair.

*Claim.*—Operating the sliding former or mandril upon the base or pedestal to keep it firm and cool, and cutting, curling, and swedging the plates of metal to be formed into the chairs while in a stationary position, and at a proper heat, on the top on the top of this sliding former, instantly to produce the chairs uniform in shape, and cheaply, of low-priced or red short iron, without fracture.

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*Making Bed-Pins.* W. McBride.

*Claim.*—Attaching to a common turning-lathe, a sliding cutter-stock, and providing stock with two peculiarly-shaped cutters, one stationary and the other moveable, the stationary cutter being of such shape that it forms a tapering part of the pin, while the moveable cutter is of a proper shape and construction to form a round head on the pin, and simultaneous therewith cut off the pin from the block, ready for being discharged. Also, making all the pins of a set of a uniform length, by employing a spring plug or gauge, and by the same means effecting their discharge after being turned, headed, and cut off.

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*Zinc White Furnaces.* J. Renton.

*Claims.*—1. The combination of any number of ore tubes and tubes or spaces, placed side by side, and communicating with each other through openings in their sides, the ore tubes being exposed to a degree of heat sufficient to evaporate the oxides or other substances contained therein, and make them pass through the openings into the tubes or spaces, the said tubes or spaces being protected from the heat by the ore tubes, and serving either to collect and condense the oxides or other vapours, or to convey them to any other suitable receptacles; 2. The hood or trunk, furnished with suitable openings for the admission of air, and placed over the air-tubes and tubes or spaces, for the purpose of receiving, leading off, and cooling the oxides or other vapours escaping from the ores.

## SEWERAGE AND DRAINAGE OF DEVONPORT.*

THE borough of Devonport is the most westerly of the three contiguous towns of Plymouth, Stonehouse, and Devonport, and is bounded by the dockyards and Morice-town, and separated from Stonehouse by Stonehouse-pool and Mill-lake. On the south-west of Devonport and Morice-town, there is a great breadth of mud exposed at low water of each tide in Millbank-lake, St. John's-lake, St. Germans, and Weston Mill-lake, which is greatly obnoxious to the surrounding neighbourhood.

The high land from Mount Edgcumbe, northward and westward, protect the towns from the north-west gales, and Staddon-heights from the south-east gales, the Sound being open to the south. The damp and warm atmosphere produced by its situation favours decomposition in Devonport, which readily taints the air, and renders the most scrupulous cleanliness and extra care in the immediate removal of all refuse matter more than ordinarily imperative.

The "three towns" are built on limestone, clay-slate, and dunstone (a semi-crystalline rock, which protrudes between the clay-slate and limestone, or intercepts them in dykes). The limestone is extensively used for building purposes, as are also the slate and dunstone. The average annual fall of rain in the district is about 35 inches; the average temperature about 2° higher than prevails on the coast of Sussex and Hampshire; 3½° higher than that of London, and 5° or 6° above that of Northumberland. Sewers have been made from time to time in detached portions to the extent of 16¾ miles, but they have been laid down without any plan, or reference to the natural facilities of the locality. Of these 16¾ miles of sewers, 29,747 lineal feet were constructed by the Commissioners of Devonport, and 58,565 lineal feet by the manor authorities and private persons. The Commissioners' sewers vary in size from 1 ft. 3 in. internal diameter, to 4 feet high by 2 ft. 5 in. wide; the other sewers vary from 2 feet by 1 ft. 4 in. to 4 feet by 2 feet. These sewers have at present three outlets within the lines of fortifications—viz., Mutton-cove, the Chamber in the dockyard, and at North-corner. The sewage of Morice-town and a portion of Upper Stoke, outside the lines, is collected into one sewer at the north end of Tamar-street, and is ultimately discharged into Hamoaze. These outlets are much complained of, as the sewage is discharged from them over the shore above low water, so as to cause offensive nuisances.

Mr. Joseph May, surgeon, and member of the Board of Commissioners, states, that "the sewers were most imperfectly constructed. Streets constantly required to be taken up to remove stoppages and cleanse foul sewers and drains from deposit. Night-soil percolated through the open stonework and into the subsoil on either side, presenting rather the appearance of cesspits than drains. The contents of privies are washed out into open gutters, and allowed to traverse the adjoining district, because underground drains do not exist. The surface and subsoil in many parts of the town is now reeking with foul night-soil. Houses in many parts of the town are not only undrained but overcrowded. Fever is common, and cholera has prevailed." It would appear from the above statement that the existing sewers have been more pernicious than beneficial to the town; however, active measures are now in progress to remedy these evils. Devonport is at present most imperfectly supplied with impure water by a company acting under the powers of a local act passed in 1793. "The works consist of a considerable drainage area, 4467 acres, a portion of which is upwards of 1300 feet above the level of the sea; the mountains around rising to 1800 and 2000 feet above the sea; the district is exposed to south-west winds, which are moist. The company takes the waters of three rivers near their source, West Dart, Cowsic, and Black-brook. The subsoil of the gathering-ground is for the most part decomposed granite, in part covered with peat. Water from the West Dart and Cowsic is beautifully bright and pure; that from Black-brook is discoloured, and in wet weather is turbid: this water flows from a morass of several square miles, which acts as a sponge in very dry weather; on this account the Devonport works can withstand a drought better than the Plymouth works. There are several natural agents which cause the company trouble: in summer evaporation carries off much water, and at all times the subsoil absorbs a great quantity, and in winter frost and snow impede the flow. It is not uncommon for the leat to be buried 20 feet deep beneath snow; on such occasions it occupies many days before the engineer can open the channel. The company, some time ago, wished to construct a large storage reservoir near the town to avoid these contingencies; there had been local difficulties sufficient to prevent their doing so. The total consumption of water from the works, so far as can be ascertained by measurement, is found to be 1½ million gallons of water per day: 800,000 gallons are used by the inhabitants of Devonport, Stoke, and Morice-town; about 351,000 gallons by the government establishments; and the residue by the inhabitants of East Stonehouse. There are about 3,500 tenants; on an average, each house, it is found, uses or wastes about 225 gallons of water each day. The average annual rental for each house supplied is 19*s.* a year; some of the houses are charged 16*s.* a year water rent: the supply is intermittent."

The West Dart river is brought into the Cowsic round a lofty mountain, then the Cowsic is brought into the Black-brook, forming the Devonport leat, which travels round Royal and passes underground for the space of 2000 feet by tunnel, which was under a ridge that separated the catchment-basin of the Plymouth Waterworks from the catchment-basin of those of Devonport. The length of the leat is thirty-five miles, and the elevation of the sources no less than 1300 feet above the level of the sea. The leat is flat until it passes the tunnel, when it passes at Stanlake-bridge, the river Meavy—the main supply of the Plymouth leat. 300 feet of fall is got rid of by a cascade at Stanlake, from which point fall is lost until the leat arrives at Roborough-down, where the leat is flat, and passes underground; then a pretty regular fall ensues, and the leat stands at 600 feet elevation above zero at Jump, six miles from Plymouth, and where any necessary head of water can be obtained. The leat next runs on to Knackerskowle, 388 feet above zero, or 370 feet above high-water mark. The next point is Mill-house, the extreme verge of the borough of Devonport, and at an elevation of 164 feet; the leat then passes round the Mill to the Lines, where it used to discharge itself into the old reservoir in Devonport, 135 feet above the sea. In 1795, the leat was cut, and the water distributed to the inhabitants through hollow trunks of trees; afterwards, one of the Rennies introduced stoneware pipes, which proved total failures, the material not sustaining the pressure, and the joints giving way. In 1820, the company established the present reservoir at Stoke-Damerel, containing 2,000,000 gallons, and supplied by a pipe brought from Brooklands, in the line of the turnpike-road. After taking what the company supposed to be good engineering opinions, a 9-inch pipe, having the immense natural fall, was laid, which proved totally inadequate for supplying the reservoir, not delivering above one third or fourth part of the water from the leat. This reservoir-pipe, and other improvements, cost 16,000*l.* or 17,000*l.* However, the Stoke reservoir enables the company to command the whole of the district of Stoke and the higher parts of Devonport.

The great bulk of Devonport is supplied from an underground reservoir, situated within the Lines, and consisting of three chambers 72 feet long, 13 feet wide, and 9 feet deep; the depth of water was 8 feet. The water is not filtered into these covered chambers, which contain about 157,000 gallons.

The second reservoir, at Outlands, Mile-house, 168 feet above the sea, supplies the Royal Naval Hospital, part of Stonehouse, the Marine Barracks, and the Long-room point. The next point at which water was taken up is at the back of Morice-town, for the supply of part of Morice-town and the Gasworks, and then at Navy-row are small tanks for the supply of the remaining portion of Morice-town,—a most defective method of supplying water to the inhabitants, the water being drawn direct from the leat. Finally, the leat-water is delivered into the Granby covered reservoir, which supplies the government barracks, dockyard, Gun-wharf, Lines, and the whole of the lower portion of the town of Devonport, making altogether three distinct distributing apparatus, worked on the intermitting system. The minimum supply of water in summer time which the leat could obtain was 1000 gallons a minute; in wet seasons it rose to 2800 gallons a minute. The rain-fall on Dartmoor is about 56 inches per annum.

In consequence of the uncertain supply derived from these sources, evaporation in summer, and frosts in winter, when it is no uncommon thing for the leat to be buried 20 feet deep in snow, the company has been anxious to provide an extensive store reservoir in the immediate vicinity of Devonport; but owing to indifference on the part of the manor authorities, and legal dis-

* Extracted from the Report of Mr. Robert Rawlinson to the General Board of Health.

abilities in the way of transferring the freehold of the land selected by them at Brooklands, together with other insuperable difficulties incident to a neighbouring mining company, they have been obliged to abandon the project. The company is now in treaty for another site, sufficiently large to construct a reservoir of five or six acres in extent, so as to provide the town against the consequences of frost and drought. It is also intended to lay down 12-inch pipes by the side of the present 9-inch main from Knackerskowle into Devonport, so as to supply the whole of the consumers constantly and at high pressure.

The situation of the proposed distributing reservoir was to be near the north-east boundary of the parish, and the top water to be about 130 feet above low-water mark on the dockyard gauge. Its clear contents are to be in round numbers 18,700,000 imperial gallons; the total reserve with existing reservoirs would then equal 21,000,000 gallons, calculated to serve the inhabitants and government for thirty-one days. These calculations emanate from Mr. Bampton, and do not appear at all satisfactory to the committee of the Town Council, who produce in evidence against them, the suggestions of Mr. Bampton himself, with respect to the improvements in Plymouth, in which he says, "about eight acres of land would be required for settling reservoirs; this is just the quantity necessary for the single new reservoir at Devonport. The storage reservoirs at Meavy should be capable of affording an auxiliary supply of 1,000,000 to 1,500,000 gallons during four months of the year, to meet the exigencies of dry seasons. Each acre immersed 16 feet on the average, would contain 4,000,000 gallons, or forty-five acres would contain 180,000,000, being adequate to 1,500,000 gallons auxiliary for 120 days. With banks, roads, &c., the quantity required for this storage reservoir would not be less than sixty acres."

In the Report of Mr. Rawlinson to the Board of Health, he says that, "the district in which Devonport is situated affords natural means for one of the best and most complete water supplies; granite mountains, elevation, a great breadth of available land sufficiently near, a moist atmosphere, and an excessive rain fall. Works to bring in water were completed in the time of Queen Elizabeth, and up to this day they remain in a rude, unfinished, and most improper state. Water is taken from open streams after surface contamination: it is conducted to the towns by means of open channels, '*leats*,' contouring hill-sides; passing through farm-yards, cultivated lands, and receiving surface washings, without filtration, from these, as also from adjoining roads. Water, so collected, is distributed for use intermittently, through cast-iron mains and lead service pipes. Filling and emptying the mains produces rust. The open leat admits mud and other contaminating material; light and air produce vegetation and animalculæ, so that at no time is the water fit for drinking. The intermittent mode of supply compels the poor to receive their water in tubs, pots, pans, and other open vessels, which expose it to all the gaseous contaminations of crowded dwellings. The price charged for water so supplied being more than is necessary to collect the springs at their source, and preserve the water pure until it is delivered within each room at high pressure, and by constant service.

"In these remarks it is not intended to cast undue censure upon the existing water company, but rather the more forcibly to draw attention to the subject. Devonport has increased rapidly in population; huge works have been established by Government, and it has become imperative that some improved form of water supply should be established for a population so large and so important. There are many reasons why a public water supply should be in the hands of a popular body. Water is required without stint for washing footwalks, channels, lanes, courts, alleys, backlets, &c.; as also for watering streets and roads, for public baths, and for public wash-houses. A company may sell in bulk for these purposes, and profitably, even at comparatively low charges, if the works have been properly devised and are economically managed. An excessive charge diminishes consumption, fosters discontent, and sooner or later begets successful rivalry. The present company must either sell their works at their value as assessed by a jury, or they must entirely alter their mode of collection, storage, and supply, and reduce their charges. The springs should be taken at their source, the water should be conducted in closed earthenware or cast-iron aqueduct conduits into covered service reservoirs, from which it should be delivered free from contamination by means of proper house services within each house and tenement. Nothing short of this will be satisfactory."

With these remarks we quite agree, and at the same time deplore that the office of supplying the inhabitants of the towns of Plymouth, Devonport, and Morice-town, together with the neighbouring districts, should be entrusted to so many independent and antagonistic bodies of officials and divided jurisdictions, instead of a combined plan being entered into by all, for their common benefit. At present, the arrangements in all these places are most imperfect and unsatisfactory. In the town of Devonport, the annual rate of mortality to 1000 persons is 27; the cholera, in 1849, made fearful havoc amongst the lower class, whose dwellings are densely overcrowded and entirely devoid of drainage. The density of population to houses in Devonport is double that of the average of all England, and the mortality is about 7 in each 1000 over the same average.

The Report sets forth—"That a new and complete system of drainage, a full and pure water supply, and efficient street cleansing, are required; that one local board of management should be established for all municipal and sanitary purposes; that the existing water supply is impure and irregular, and the company's charges unequal and excessive; that the sewerage and drainage is limited in extent and defective in practice, without any systematised plan of procedure; that the present system of cleansing streets and removing house refuse is imperfect;" and recommends the establishment of public baths and washhouses, and proper receptacles for the dead; and also recommends that the mayor, aldermen, and burgesses of Devonport be nominated as the local board of health for the district.

## PERMANENT WAY.

JOHN PYM, *Patentee*, March 29, 1853.

THIS invention consists in constructing sleepers (which are transverse sleepers) of earthenware, slate, stone, or other suitable materials; and of whatever material they may be made, they are formed hollow, instead of solid as heretofore. In order to prevent what is termed sopping, the patentee perforates the bottom or sides, to allow the water to enter the interior chamber thereof, and to run off at either end. To fix the chairs upon the sleepers, where not desirable or practicable to adopt the methods now in use, the sole of the chair is formed sufficiently long to overlap the sides or edges of the sleeper; and the ends of the sole are secured by passing a bolt from side to side, through the sleeper, and fastening the same by a nut, pin, or rivet.

To prevent the jarring of the chair and sleeper, wood, felt, or other suitable material is placed between the chair and the sleeper.

*Claim.*—1. The construction of hollow perforated sleepers, as hereinbefore described; 2. The construction of sleepers of slate and earthenware; 3. The construction of chairs, and mode of fastening the same, as hereinbefore described.

## STEAM-ENGINES.

NATHANIEL CLAYTON and JOSEPH SHUTTLEWORTH, *Patentees.*

THIS improvement consists in placing the working cylinder or cylinders of portable or locomotive steam-engines in a steam-chamber or jacket within the smoke-box, whereby condensation of steam within the cylinder, and radiation of heat therefrom, is effectually prevented.

The form of the steam-chamber or jacket, its position within the smoke-box, and the communication between the steam-chamber and the boiler, may be so disposed and varied as to suit the particular construction of the engine, and the purpose for which it is used,—the best arrangements of which will occur to any intelligent workman. The patentees remark, that they are aware that the working cylinders of steam-engines have been heretofore surrounded by a steam chamber or jacket, and also that the working cylinders of locomotive and portable steam-engines have been sometimes placed within the smoke-box; but they have found considerable advantage to arise from surrounding the working cylinder with a steam-chamber, such steam-chamber being placed within the smoke-box of the engine.

*Claim.*—The combination of surrounding the working cylinder or cylinders of portable and locomotive steam-engines with a steam chamber or jacket, placed within the smoke-box of the engine.

## REVIEWS.

*Lectures on Architecture and Painting, delivered at Edinburgh in November* 1853. By JOHN RUSKIN. London: Smith, Elder, and Co. 1854. pp. 239.

WE are very glad to see this book; we strongly recommend our architectural readers to buy it, for it is a cheap one, and not a very big one, and it will enable them to understand what Mr. Ruskin is, though they are none the more likely to understand what he says or means. We are very thankful to Mr. Ruskin for publishing this book, as it can be read or looked through, while his more ponderous tomes frightened away many a sober reader, who therefore took Mr. Ruskin's reputation by hearsay and on trust from his admirers. This little volume is the quintessence of Ruskinism; it contains in a concise form the doctrines of the great master on the subject of art as exemplified in Architecture, Turnerism, and pre-Raphaelitism; and as it is printed *permissu superiorum*, its authenticity cannot be gainsaid. The papal authority of Ruskinism has issued this bull, and the faithful must acknowledge its infallibility until the said authority again changes the infallible decrees.

This is no inferior work of the great master; it boasts all the vigour of his mind, and is marked with his distinguishing characteristics, and if at other times his effusions have been of greater length, they have never been more authoritative or more precise in their terms. We say that this book shows what Mr. Ruskin is, and the portrait so daguerreotyped is not a flattering one. Whether we look at Mr. Ruskin's conclusions, or the means by which he proposes to arrive at them, the impression is equally unsatisfactory. The unprejudiced reader will wonder how such a man can have been so bepraised and held up as an authority, before which artists and the public were to bow in reverence.

It is in the spirit of cliqueism that we must seek the solution of the riddle. As a University man he received the support of many members of the press on his first appearance as an author, and he has since been bepuffed and belauded by the confraternity of Puseyites in its various sects. In this band of misguided and wrong-minded men, Mr. Ruskin is one of many who, like Newman, Pusey, and others, have united genius with debasing superstition and mystic cant. Then, too, he made his debut cunningly on a subject where, though the *modus operandi* was the canonical one, the end was not recognisable neo-catholic. Mr. Ruskin's homilies on Turner, nevertheless, had all the marks of its parentage,—they were dogmatical and intolerant; they were mystified and mysterious. Even in this day, without fear of exclusion from the fold of neo-catholicism, he can revert to Turnerism, and bring it within the limits of his orthodox works. The public, who would have shrunk back from openly-avowed Puseyism, listened on a subject of art; they admired his eloquence, his subtlety, his fervour, as they would those of a Jesuit preacher. Profiting by this reception, Mr. Ruskin, having got the ear of the public, has proceeded until he is a recognised missionary of neo-catholicism.

Just as the Jesuits of the Roman Catholics adopt various disguises and resort to various schemes, to get access to the population whom they propose to corrupt, so do the Jesuits of Anglo Catholicism. Diverse in means, sometimes conflicting in opinion, their end—that of enslaving the minds of a free people—is the same. One writer advocates the sports of the middle ages, and would lead the flock to the confessional through the cricket-ground, albeit his love of art and nature is not so great as that of some of his brethren.

> "Let *arts* and learning, trade and commerce die,
> But give us still our old nobility."

Some, earnest in points of architectural æsthetics, attach themselves to symbolism, and catch the ears of the unwary country parson, who straightway gives himself up to the vesica piscis, to sedilia, monstrances, and candles lighted or unlighted. Young ladies of pious aspirations, who are content to marry curates and make love to vicars, are led to embroider altar-cloths instead of slippers, and to decorate the church instead of the boudoir. The lover of song is awakened to the horrors of the nasal twang of charity children, and lends himself to the Gregorian chant, little thinking that his part in the play is subservient to that of Pope Gregory himself, whose Hildebrandine pretensions are the real aims of his art-loving leaders. If a man has a love of masonry, they claim him for the freemasons of the church, and persuade him he is restoring an institution of the middle ages which in the middle ages was unknown. The painter is appealed to; the love of mysticism, which in inferior minds stands in the stead of genius, or is the alloy of it, is fostered, and Hunt, Millais, Rossetti, and other like disciples are enlisted. Thus the forms of the middle ages are restored,—and be it not supposed that the spirit is wanting. Pope Gregory the Great will never die while sect or priest exists, and the haughty and overbearing monkery of the middle ages will always find fitting copyists in narrow-minded pedagogues and over-weening parsons. Thus is got together an army of co-operating bodies, neither confederates nor allies, moved by their own special objects, but made to unite in the promotion of one great end, which they are ignorant or heedless that they are fulfilling.

There is one marked characteristic and distinction in all this movement. With all the zeal for the revival of the middle ages in their entirety, there is no desire to revive forms of most national freedom and individual independence, which are the most truly interesting features of the middle ages, which are the germs of our free institutions, and many ancient types of which could worthily be imitated or restored. How little of the spirit of a Dante, a Chaucer, or a Wickliffe enters into the proceedings of the mediævalists; how little do we see of the freshness of genius, of the halestrong vigour of thought, of the noble expansion of mind. What they seek to restore is the slavery of mind from the cradle, the debasement of thought, and its confinement within fetters of which priests indeed bear the keys, but which are never used to unlock. The inculcation of a mind-debasing mysticism is pernicious enough, but to subject the human reason to that ecclesiastical tribunal which for so many ages has warred with free thought, more strongly marks the insidious enterprise for evil. The fate of architecture under such an influence can be only that of the other arts;—the genius of its professors must be unshackled in order to have free scope. Degrading restrictions are however laid down to trammel the aspirant; to one style of architecture his exertions must be confined, and the precedents of the ancients and the dictations of the priest are to be his strict guides. The canons of taste are to be abandoned for the mystical relations of magical numbers and colours and forms, trine and septenary, legends and symbols and types. Against such influences it becomes every well-wisher of architecture to protest, as they can only operate to the retrogradation of art.

In the middle ages, there were holy and salutary influences, there were free and noble inspirations, which ennobled the artist. In the contest of mind against priestly thraldom and superstition, which ultimately resulted in the liberation of a large part of Europe, the poet and the artist were found enrolled on the side of independence, and they were co-operators with the priest in consequence of the latter conceding to the claims and merits of the artist. Had the artist been, as Mr. Ruskin and his fellow-disciples believe and wish, the slave and tool of the priest, we should never have witnessed those noble works which it is supposed the call of the priest can now reproduce.

As a missionary of the neo-catholic system for the enslavement of the human mind, Mr. Ruskin made his appearance in Edinburgh—an enterprise daring in its conception, and craftily carried out. Edinburgh is a place where the morbid horror of popery overcomes the inherent love of the beautiful, engendered among a poetical people by constant association with the most romantic scenery, and earnest sympathy with the works of nature. Mr. Ruskin begins by praising the modern Athenians and modern Athens beyond even the degree of Scotch laudation, and that distribution of mutual and reciprocal praise in which the lowlanders proverbially indulge. On the strength of this glorification, Mr. Ruskin proceeded to pour into the fascinated ears of his auditory the choicest dogmas which distinguish his system; but fortunately he has gone further, and having printed his lucubrations, he has given his dupes the opportunity of scanning at leisure those passages which in their delivery too readily met with acquiescence and acceptance.

Earnest in the propagation of false doctrines, he possesses the zealous spirit which distinguishes many such missionaries, and which gives his style an air of earnestness, impressiveness, and (so far) of originality, as to claim by sympathy the ready concurrence of the unreflecting. By appealing boldly to the prejudices of his auditors, he gains a hearing for crotchets of his own, which pass muster on the credit of their introduction. Mr. Ruskin is necessarily less a reasoner than an advocate,—less a logician than a sophist,—less anxious for truth than for the propagation of a sect and a faith. Many of his assertions are simple concessions to his listeners, and his own system is one of paradoxes and of mystical formulæ. Thus is brought together a mass of contradictions, such as a masked Jesuit can alone parallel. The pre-Raphaelite appeals to John Knox to court his audience, and to the bible because the bible is the superstitious shibboleth of the northern Athenians. An appeal to John Knox the iconoclast comes passing strange from such lips, and the bible appealed to as a standard of thought among the bold spirits of the north affords the Puseyites and mediævalists only a convenient story whereon to string a series of subjects. For a sample we give the following example:—

"Whatever has been advanced in the course of this evening, has rested on the assumption that all architecture was to be of brick and stone; and may meet with some hesitation in its acceptance, on account of the probable use of iron, glass, and such other materials in our future edifices. I cannot now enter into any statement of the possible uses of iron or glass, but I will give you one reason, which I think will weigh strongly with most here, why it is not likely that they will ever become important elements in architectural effect. I know that I am speaking to a company of philosophers, but you are not philosophers of the kind who suppose that the Bible is a superannuated book; neither are you of those who think the Bible is dishonoured by being referred to for judgment in small matters. The very divinity of the book seems to me, on the contrary, to justify us in referring *every* thing to it, with respect to which any conclusion can be gathered from its pages. Assuming then that the Bible is neither superannuated now, nor ever likely to be so, it will follow that the illustrations which the Bible employs are likely to be *clear and intelligible illustrations* to the end of time. I do not mean that every thing spoken of in the Bible histories must continue to endure for all time, but that the things which the Bible uses for illustration of eternal truths are likely to remain eternally intelligible illustrations. Now, I find that iron architecture is indeed spoken of in the Bible. You know how it is said to Jeremiah, 'Behold, I have made thee this day a defenced city, and an iron pillar, and brazen walls, against the whole land.' But I do not find that iron building is ever alluded to as likely to become *familiar* to the minds of men; but, on the contrary, that an architecture of carved stone is continually employed as a source of most important illustrations. A simple instance must occur to all of you at once. The force of the image of the Corner Stone, as used throughout Scripture, would completely be lost, if the Christian and civilised world were ever extensively to employ any other material than earth and rock in their domestic buildings. I firmly believe that they never will; but that as the laws of beauty are more perfectly established, we shall be content still to build as our forefathers built, and still to receive the same great lessons which such building is calculated to convey; of which one is indeed never to be forgotten. Among the questions respecting towers which were laid before you to-night, one has been omitted: 'What man is there of you intending to build a tower, that sitteth not down first and counteth the cost, whether he have sufficient to finish it?' I have pressed upon you, this evening, the building of domestic towers. You may think it right to dismiss the subject at once from your thoughts; but let us not do so, without considering, each of us, how far *that* tower has been built, and how truly its cost has been counted."

From the false position on which Mr. Ruskin first entered, he never escapes, had he even the desire to do so. Empty description and paradoxical assertion form the staple of each discourse. To examine such a work seriously, or to contrast its prepositions, would be an utter waste of labour, and a grievous affliction on the patience of our readers. If there are any Ruskinists among architects, it would be fruitless to attempt to change their convictions; but as architects are men of sense, they need but little to enable them to appreciate the exertions of Mr. Ruskin. With them, Mr. Ruskin is not an authority on matters of art or of taste, nor is he likely to become so, and they will listen to his dicta with more impatience than attention.

After a great deal of parade about what Mr. Ruskin has done and was to do for architecture, and about the new style he was to invent, it turns out that his grand system is, to introduce the mediæval styles in all their completeness; a doctrine which it needed no new expositor to lay before the architectural world, as it was propounded by Mr. Pugin,—so that Ruskinism turns out to be only a new name for Puginism, with the difference that Mr. Pugin was a practical man.

It is very dangerous to quote from Mr. Ruskin what seems to be right, for there is so much error mixed up, that it is scarcely possible to get at anything straightforward. As to give examples of choice *morceaux* of Ruskinism is a waste of print and paper, we hardly know whether we are justified in stating that the following piece of tomfoolery is an exemplification of Mr. Ruskin's theory of style:—

"You must all, of course, have observed that the principal distinctions between existing styles of architecture depend on their methods of roofing any space, as a window or door for instance, or a space between pillars; that is to say, that the character of Greek architecture, and of all that is derived from it, depends on its roofing a space with a single stone laid from side to side; the character of Roman architecture, and of all derived from it, depends on its roofing spaces with round arches; and the character of Gothic architecture depends on its roofing spaces with pointed arches, or gables. I need not, of course, in any way follow out for you the mode in which the Greek system of architecture is derived from the horizontal lintel; but I ought perhaps to explain, that by Roman architecture I do not mean that spurious condition of temple form which was nothing more than a luscious imitation of the Greek; but I mean that architecture in which the Roman spirit truly manifested itself, the magnificent vaultings of the aqueduct and the bath, and the colossal heaping of the rough stones in the arches of the amphitheatre; an architecture full of expression of gigantic power and strength of will, and from which are directly derived all our most impressive early buildings, called, as you know, by various antiquaries, Saxon, Norman, or Romanesque. Now the first point I wish to insist upon is, that the Greek system, considered merely as a piece of construction, is weak and barbarous compared with the two others. For instance, in the case of a large window or door, if you have at your disposal a single large and long stone you may indeed roof it in the Greek manner, as you have done here, with comparative security; but it is always expensive to obtain and to raise to their place stones of this large size, and in many places nearly impossible to obtain them at all: and if you have not such stones, and still insist upon roofing the space in the Greek way, that is to say, upon having a square window, you must do it by a miserably feeble adjustment of bricks. You are well aware, of course, that this latter is the usual way in which such windows are now built in England; you are fortunate enough here in the north to be able to obtain single stones, and this circumstance alone gives a considerable degree of grandeur to your buildings. But in all cases, and however built, you cannot but see in a moment that this cross bar is weak and imperfect. It may be strong enough for all immediate intents and purposes, but it is not so strong as it might be: however well the house is built, it will still not stand so long as if it had been better constructed; and there is hardly a day passes but you may see some rent or flaw in bad buildings of this kind."

As the book before us is strictly a reprint from Mr. Ruskin's lectures, and has engravings from the original illustrations to which frequent references are made, it is further difficult to find passages conveniently adapted for quotation, were we even disposed to take advantage of the opportunity. We are nevertheless tempted by the following:—

"I have hitherto appealed only to your national pride, or to your common sense; but surely I should treat a Scottish audience with indignity if I appealed not finally to something higher than either of them,—to their religious principles.

"You know how often it is difficult to be wisely charitable, to do good without multiplying the sources of evil. You know that to give alms is nothing unless you give thought also; and that therefore it is written, not 'blessed is he that *feedeth* the poor,' but, 'blessed is he that *considereth* the poor.' And you know that a little thought and a little kindness are often worth more than a great deal of money.

"Now this charity of thought is not merely to be exercised towards the poor; it is to be exercised towards all men. There is assuredly no action of our social life, however unimportant, which, by kindly thought may not be made to have a beneficial influence upon others; and it is impossible to spend the smallest sum of money, for any not absolutely necessary purpose, without a grave responsibility attaching to the manner of spending it. The object we ourselves covet may, indeed, be desirable and harmless, so far as we are concerned, but the providing us with it may, perhaps, be a very prejudicial occupation to some one else. And then it becomes instantly a moral question, whether we are to indulge ourselves or not. Whatever we wish to buy, we ought first to consider not only if the thing be fit for us, but if the manufacture of it be a wholesome and happy one; and if, on the whole, the sum we are going to spend will do as much good spent in this way as it would if spent in any other way. It may be said that we have not time to consider all this before we make a purchase. But no time could be spent in a more important duty; and God never imposes a duty without giving the time to do it. Let us, however, only acknowledge the principle;—once make up your mind to allow the consideration of the *effect* of your purchases to regulate the *kind* of your purchase, and you will soon easily find grounds enough to decide upon. The plea of ignorance will never take away our responsibilities. It is written, 'If thou sayest, Behold we knew it not; doth not he that ponderth the heart consider it? and he that keepeth thy soul, doth not he know it?'

"I could press this on you at length, but I hasten to apply the principle to the subject of art. I will do so broadly at first, and then come to architecture. Enormous sums are spent annually by this country in what is called patronage of art, but in what is for the most part merely buying what strikes our fancies. True and judicious patronage there is indeed; many a work of art is bought by those who do not care for its possession, to assist the struggling artist, or relieve the unsuccessful one. But for the most part, I fear we are too much in the habit of buying simply what we like best, wholly irrespective of any good to be done, either to the artist or to the schools of the country. Now let us remember, that every farthing we spend on objects of art has influence over men's minds and spirits, far more than over their bodies. By the purchase of every print which hangs on your walls, of every cup out of which you drink, and every table off which you eat your bread, you are educating a mass of men in one way or another. You are either employing them healthily or unwholesomely; you are making them lead happy or unhappy lives; you are leading them to look at nature and to love her—to think, to feel, to enjoy,—or you are blinding them to nature, and keeping them bound, like beasts of burden, in mechanical and monotonous employments. We shall be all asked one day, why we did not think more of this.

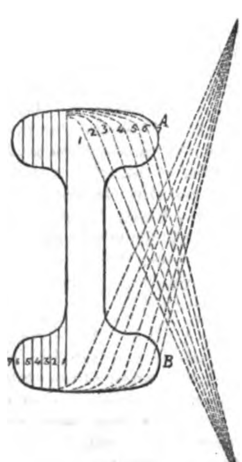
"Well but, you will say, how can we decide what we ought to buy, but by our likings? You would not have us buy what we don't like? No, but I would have you thoroughly sure that there *is* an absolute right and wrong in all art, and try to find out the right and like that; and, secondly, sometimes to sacrifice a careless preference or fancy, to what you know is for the good of your fellow-creatures. For instance, when you spend a guinea upon an engraving, what have you done? You have paid a man for a certain number of hours to sit at a dirty table, in a dirty room, inhaling the fumes of nitric acid, stooping over a steel plate on which, by the help of a magnifying glass, he is, one by by one labouriously cutting out certain notches and scratches, of which the effect is to be the copy of another man's work. You cannot suppose you have done a very charitable thing in this! On the other hand, whenever you buy a small watercolour drawing, you have employed a man happily and healthily, working in a clean room (if he likes), or more probably still, out in the pure country and fresh air, thinking about something, and learning something every moment; not straining his eyesight, nor breaking his back, but working in ease and happiness. Therefore if you *can* like a modest watercolour better than an elaborate engraving, do. There may indeed be engravings which are worth the suffering it costs to produce them; but at all events, engravings of public dinners and laying of foundation stones, and such things, might be dispensed with. The engraving ought to be a first-rate picture of a first-rate subject to be worth buying."

## PERMANENT WAY.

JOHN SHAE PERRING, *Patentee*, August 1, 1853.

THIS invention relates to an improved form of that part of the permanent way of railways called points or switches, and consists in so forming the rails which constitute such apparatus, that they can be turned over and used on either side—that is to say, the two moving or tongue rails are cut or otherwise formed to a pattern which will admit of their being adapted either side up, so that when the one surface is worn out, the other may be brought upward for the carriages to run upon, and in like manner the fixed rails are constructed which constitute the other portions of switches.

The annexed engraving represents an end elevation of one of the switches, *a b* explaining the sections thereof at various points. Upon the figure are marked the several numbers, 1, 2, 3, 4, 5, 6, 7, which indicate the sectional shape of the rail at various points; such sections gradually increase in breadth as the wheels of the carriage lose their bearing upon the fixed rail, that at 7 being of the full breadth. The upper part A, and the lower part B, are of the same form, so that when the one is worn out, it may be turned upside down, and moved to the other side, as from *a* to *b*, which latter being also in like manner shifted, so as to occupy the place of *a*, two new surfaces will be obtained as bearings for the train. The fixed rails *c*, of the switch are formed in the same manner, so that they may be reversed when desired, and present the proper relative shapes to the moveable parts *a*, *b*.




## PREVENTING COLLISIONS ON RAILWAYS.

W. GOSLING, Woolwich, *Inventor*.

THIS apparatus consists of a pendulum attached to the under side of a locomotive tender, which, coming in contact with a stop when turned up on a sleeper, causes it to raise a lever which is placed by the side of the tender. Connecting-rods are attached to this lever, which raise the break, turn off the steam, and ring a bell to apprise the driver of danger. Attached to the driver's bell are wires, which pass under each of the carriages, and by a peculiarly constructed crank the bell can be rung whether the train is travelling on a level or descending an incline, so that the guard or any passenger can immediately give warning to the driver in the event of danger. A lever is also provided on the engine, which is made to act upon every carriage-wheel, so that the train would not pass over more than fifty yards after the breaks are applied; consequently any collision would be prevented.

## TEMPERING, GRINDING, AND POLISHING STEEL, AND OTHER METALS.

JAMES CHESTERMAN, *Patentee*, November 1, 1853.

THIS invention consists—First, in the process of hardening and tempering strips or plates of thin steel, such as saw-blades, &c. The coil of steel is wound into a circular cast-iron case, in the side of which is an aperture through which one end of the coil protrudes. The case is then closed in by a cast metal lid, and placed in the furnace, where it remains until red-hot. It is then removed, and the strip of steel is drawn out through the aperture in the case, and passed between a pair of cold steel, metal, or stone dies or plates, by which it is hardened and flattened. Means are provided for keeping the dies or plates cool. Smaller and thicker lengths of steel are placed in the furnace until red-hot, and then subjected to pressure between two dies or plates, mounted in the manner of a press; the effect of which treatment is to harden the steel and prevent it from warping or buckling. The press is cooled by the application of cold water to it. These shorter lengths are tempered in the ordinary manner, but the thin strips of steel are removed, after passing from the dies, to a stretching table, where one end is secured between screw-clamps, or otherwise, and the other end is clipped between another pair of screw clamps attached to a leather strap, which is fastened to a drum or roller furnished with a lever, weighted so as to produce a gentle strain on the steel. Oil or grease is then applied to the steel, and blazed off by the heat of a portable furnace or gas-light, or other source, which imparts a fine spring temper to the steel, and flattens it at the same time. The steel, after passing from the hardening-dies, may be drawn through a fixed gas-furnace, thus rendering the two operations of hardening and tempering continuous.

Secondly, in the process of grinding both sides of a flat article, or the entire periphery of a circular or similar shaped articles. Upon a central tube or axis is attached a cylindrical grindstone, which is made plain or indented with semicircular or other grooves, according to the shape of the article to be ground. A second similar grindstone is mounted over the first. Rotary motion is imparted to these rollers, and the article to be ground is passed through them in a direction contrary to that of the rollers. When the articles to be ground are flat, the sides of one of the rollers are provided with collars or flanges formed of grindstone, and of larger diameter than the roller, which effects the grinding of the edges as well as the sides of the article when requisite. These rollers are capable of adjustment to the varying thickness of different articles. When one side only of a steel or metal article is required to be ground, a plain wooden roller is substituted for one of the grindstones. Combined with this arrangement are guide-rollers for cross-grinding.

Thirdly, the inventor employs in the operations of glazing, buffing and brushing blades of steel and other metal articles, two similar rollers formed of soft wood, with emery on the surface, or buff leather or bristles, or partly of buff and partly of bristles.

By these improvements, men engaged in grinding will be enabled to stand to their work at a much greater distance from the stones than at present, and in front of the stones instead of leaning over them; they will thereby be less liable to the injurious effects of the stone grit, and more removed from danger in the event of a stone flying to pieces.

## ARCHITECTURE IN THE ROYAL ACADEMY EXHIBITION.

The fine art collections are now in full glory, and first and foremost the "Royal Academy of Painting, Sculpture, and Architecture." We propose conducting the reader, to the best of our ability, through the comparatively small portion of the exhibition devoted to the latter subject, but, before starting, it will be well to get a notion from the catalogue of what we are likely to see,—and what we shall not. This latter clause we may safely add, remembering the experience of past years, and perceiving that the usual complement is this year maintained; and it revives in us the annual wonder at the patience and ingenuity so largely taxed to cram 1531 works of art within the given space. What a pity 'tis that *quantity* is still so much the desideratum, and that in the item of their being hung, though "excessive breadth in frames may prevent pictures obtaining the situation they otherwise merit," a lucking-fitting frame stands a better chance than a good picture of less happy dimensions.

To say nothing of the endless monotony and manifest absurdities which this system occasions, nor of its detracting influence on the subject it professedly seeks to promote: not to allude to the disheartening effect on many a one who chuckled at his good fortune in being admitted an exhibitor, till he descried his favoured effort in some spot over which his familiar eye had repeatedly wandered without its detection, and then, in the depth of chagrin, as heartily wished his work as safely *out* as he had been overjoyed to learn it was *in*:—not to dwell on these matters, if it were only for the sake of the plodding, gazing public who go and pay their shilling, anticipating a feast on the good things before them; and so, beginning with right goodwill at the "Cheetahs" of No. 1, follow on seriatim till a bewildering surfeit comes over them, and they make a hasty exit, with but chromatropic ideas of the pictures they have beheld, but with sensibly stiff necks, aching heads, and strained optics;—we wish it were otherwise. How can the public taste thus be expected to improve, or a relish be created for that art of which they have, generally speaking, but little notion? The necessity for a separate architectural exhibition is every day more apparent. We do not desire to run counter to the Academy; but it is evident that its numbers and predilections so vastly preponderate in one channel, that the other sister-arts (as they are called) are now shamelessly slighted, and must seek to secure some footing of their own. The exclusively architectural exhibitions which have been held, though under many and manifest disadvantages, have shown the disposition both on the part of the profession and of the public to foster such a scheme, and we hear that there is a possibility of the greatest obstacle to its establishment—the want of a permanent gallery—being overcome. At any rate there is to be a meeting of the subscribers and friends on the 7th of this month (June), at the rooms of the Institute of British Architects, in connection with the subject. An annual collection of purely architectural drawings—not showy or tricky ones got up for the purpose—would be instructive, interesting, and easily available, and would especially serve to indicate the current tone of feeling among all parties around.

But to return to our subject. We regret to find that not one of the Architect-Academicians has this year contributed a single production. This argues something bad, even if we infer that they are at length satisfied with honorary distinctions, and content to resign the more active duties to their juniors or less fortunate compeers. Even the worthy Professor himself, whose delightful architectural groupings are familiar to all, has this time given place to another distinguished individual who is not so frequently an exhibitor. The absence of other first architects is much to be regretted. This is an age of architectural transition; the public taste is in the act of formation; and those who ought to form it seem to shrink too much from the *désagrémens* attending the task. Art, it is universally admitted, has a high educational influence upon the mind; and architecture, perhaps, a larger influence than her sister arts, since it is more universally present in the social and religious life of the people. The architect, then, is a public teacher, and when he is invited to come and preach sound principles to the great assembly of art-disciples who come here year by year for instruction, he is surely neglecting a duty when he leaves it to the inferior members of his profession to disseminate meagre or false teaching, without let or antidote.

The architectural drawings are placed in the same room as usual, which once bore a corresponding title; this has been of late exchanged for the more chilly one of "North Room," since canvas paintings are now permitted to overhang and overwhelm our poor paper drawings. However, we are allowed, this year, *three* sides of the apartment instead of *two*.

The most elaborate drawing on the walls is the one to which we have referred, by Mr. Tite, and it appropriately faces the spectator on entering the room. It is (1172) a composition of the works of Inigo Jones, including his full design for the Whitehall palace; views of old St. Paul's, as altered by him; also old Somerset House, Covent-garden and Church, Stoke, Ambresbury, Drumlanrig, Burley on the Hill, Castle Ashby, the Water-gate (London), parts of Greenwich Hospital, St. John's College, Wilton, the Queen's house at Greenwich, Heriot's Hospital, Coleshill, and other houses; and in the distance his mill and Llanwrst Bridge. These form, as will be imagined, a magnificent group, and contain a mine of valuable study. No. 1121 is also an important drawing, and more attractive at first sight than that just named. In it Mr. J. D. Harding has lavished his well-known skill in landscape delineation, to set off the new Crystal Palace and grounds, showing the fountains that are to perform such wonders, and also the restored antediluvian creatures (which look like giants according to the apparent scale of the picture), in and about the lake. Nos. 1168 and 1234 give us more ideas of the fairy scenes to be enacted at Sydenham under the magic wand (or hand) of Sir Joseph Paxton. While speaking of this place, we may mention, that Mr. G. H. Stokes has a view (1152) of the Sheffield Court as it is to appear when complete and fitted up. The Pompeian restorations of Mr. E. Falkener (1173, 1174, 1175,) are beyond all praise for care and delicacy of treatment, and the coloured decorations introduced, "for the general character of which there is abundant authority," are gorgeously rich, yet without gaudiness. The secret of this result we, in England, have yet to learn. Near Mr. Falkener's drawings is one by Mr. M. D. Wyatt (1162) of the Pompeian house now being erected in the Crystal Palace, in which the coloured enrichments form a principal feature. These, which are here cleverly shown, have been in the original "executed under the superintendence of Signor Abbate, of Naples, from tracings made upon the walls of the principal buildings in Pompeii;" so that we may rely on the fidelity of the translation.

There are a great many views of public buildings in course of erection, and of designs for others, a few of which we must notice. No. 1228 is the "Town Hall at Leeds" about to be erected from the designs of Mr. Brodrick. It shows an ample use of columns engaged and detached, both in the building itself, and in the tower which it is now proposed to add. "The Public Rooms and Corn Exchange, Kidderminster, by Messrs. Bidlake and Lovatt," form the subject of (1144). This is a very good Italian composition, and shown to advantage by excellent colouring. The preceding number (1143) is attached to a view of a design submitted in competition for the "Music Hall and Assembly Rooms, Newcastle," and which obtained the first premium of 100 guineas. It is the interior which is shown; it has a dull heavy appearance; partly, it may be, owing to the way the drawing is tinted;—decorative enrichment in colour is not indicated, but it would certainly be needed. There is considerable boldness and better effect in an "Interior, by Mr. E. B. Lamb, of the Exchange and News-room in the proposed Town Hall, Preston" (1135), in which arches in various directions, springing from columns, are judiciously introduced; the room is partially lighted by glazed panels in the ceiling. In (1188) we have an exterior view of another "Town Hall at Wakefield, about to be erected from the plans of G. T. Robinson." This design somewhat lacks identity of character, the front being spread out by long wings which do not explain their purpose; and it is otherwise deficient, especially in sculpture, which the breaks in the attic story decidedly require. There is considerable merit in the "Houses now being built in Ashley Place, Victoria-street, Westminster," and Mr. Ashton's drawing of them (1111) scarcely does them justice. It is a pity the heights of the different floors are so nearly equal, but we know the awkwardness in such cases, as well as the difficulty of combining the whole symmetrically. Had the top story been made less important, and a bolder cornice been used, we venture to think the façade would have been improved. The great feature in the plan (and it shows externally) is the large open staircases, screened from the street by arcades, &c., in continuation of the main line of the front, "on the Scotch principle," as it is expressed in the catalogue. In (1131) "Chambers erecting in New

Cannon-street, J. Belcher," this equality of division in the stories is again detrimental to the design. Another important contribution to our metropolitan street architecture is shown in (1171) "New Warehouses of Messrs. J. and R. Morley, Wood-street, Cheapside, built under the superintendence of Mr. J. Wallew." This is a very fine range of building, reminding one of the similar stately establishments in Manchester. Not far from the last mentioned is the "Australasian Bank, now being erected in Threadneedle-street," of which (1164) is a delineation, by Mr. P. C. Hardwick. This will also be an acceptable addition to our public buildings; but the outline of the plan, and some general features in the design, struck us having been previously carried out in the neighbouring "Sun Fire Office." We do not like the broken entablature against the sky-line, more particularly as there is no attic or other relief above the cornice. Mr. Armstrong's "Public Building, Newcastle-upon-Tyne" (1237) is good; the light and shade which the recessed centre (behind an arch and screened by columns in a line with the main front) secures, is by a simple and very effective scheme. The identical notion is repeated in (1138), by the same author, in a design for the Burslem Town Hall, and which gained a premium. (1224) is another competition design for the Newcastle buildings, by Messrs. Lawford and Heneker, and it obtained the first premium of 100 guineas. We presume this exterior is the companion to (1143), before noticed. There is nothing striking in the general elevation; but could not the subdivisions in the lower story be improved? At present they make what should appear, as well as be, substantial, look liny and weak. Professor Donaldson shows (1206) a scheme for exposing to public view, the sarcophagi of Nelson and Wellington, under the centre of the dome of St. Paul's, by means of a circular opening in the pavement so as to throw open part of the crypt. He styles his drawing—"An Architect's Dream." The idea was suggested, doubtless, by the similar treatment of Napoleon's tomb at the Invalides.

We find in (1137) one of the Gold Medal designs lately submitted to the Royal Academy, by Mr. J. T. Christopher. The subject, "a College, Military Academy, and Asylum for Veterans, in honour of the late Duke of Wellington," is treated on a very extensive scale, and of course with a profusion of enrichments. It forms a very pleasing composition, and the author has done well in following as his models in some parts of the design such men as Wren, Inigo Jones, and Vanbrugh. (1169) is placed too obscurely to be seen critically. It is a "Design for a Metropolitan Horse and Carriage Bazaar, by Mr. R. Suter," a good straightforward elevation, unpretendingly tinted in India-ink. There is no attempt at ornament except two or three bits of appropriate sculpture. (1196) and (1197) are designs for a college (probably in the same competition) by E. M. Barry, and by H. Field. The former is of red brick with white dressings, and on the whole exceedingly good. The centre part, in particular, has been carefully studied, and the turret rising from the roof above is unusually well designed. The other design is more homely and ordinary. (1229) "Cotton Factory Weaving Sheds, R. Rawlinson," has an air of appropriateness and character which looks well; and the same may be said of Mr. Tinkler's "Erris Fishing Settlement, County Mayo, Ireland" (1230). We cannot fall in with Luke Limner's suggestions for the glazing of the "Semicircular end windows of St. George's Hall, Liverpool." The author's name prepared us for something original,—in this case, we think, unsuccessfully; even if we grant, as he intimates has been his aim, that the jointing of the several portions should be mystified as much as possible; since the pattern on the glass is a series of delicate lines more elegantly flowing than geometrically arranged, and so wanting in concentration and evident meaning. In another part of the room (1235) is a "Cartoon, illustrating the true principles of Stained Glass," J. H. Powell, very differently conceived. This is mediævally treated, and, of course, conventionally in some degree. The incident (the offering up of Isaac) is fully told, the drawing good, and, bearing in mind the different uses of stained glass, we are disposed to think the way of handling the materials here shown is altogether the best. (1158) and (1232) are designs for Venetian Palaces—at least so-called;—we suppose because a kind of Venetian window is repeated in every space; otherwise there is an entire absence of the genuine character. (1186) "Design for a Canopied Tomb, G. Goldie," is boldly drawn and tinted, and in the ideas has some praiseworthy originality. As much cannot be said of the design for Congregational Church and Schools (1201), by E. C. Robins; nor for a similar building "now erecting," we are truly ashamed to find, "at Craven Hill, Hyde Park, from designs by A. Trimen (1179). In both these, as well as (1245), by J. James, there is a miserable attempt to mask a sprawling roof of one span by a triply-divided end or front wall; and in the Craven Hill case, the shape of flying buttresses, as if from nave over aisles, is taken advantage of (the wall of course filling them up in reality), while the ridge acts as partial coping to the said roof:—such a perpetration and outrage of principle, we have not seen for a long time. Unhappily (or perhaps by a sly humour, *in terrorem*, if we can suppose the hanging committee to be waggish), the drawing is hung immediately opposite the door! It is refreshing to pass on to (1182), by T. W. Goodman, which, though "In Nubibus," and likely to remain there, is really, setting aside a few extravagancies, a clever conception, and, as we overheard the remark, a decided "inflation!" Possibly this latter word may be applicable also to Mr. Betts's "Design for a Church Exterior" (1242), which we are not skilful enough to criticise.

Mr. F. P. Cockerell has three excellent drawings; the largest (1205) is called "Thanksgiving in St. Paul's after the Victory over the Spanish Fleet, 1718," but is in reality a nearly-west external view. From a glance at the surrounding buildings, we learn that Messrs. Cook's great warehouse was in progress of erection at the time; and the scaffolding here shown was only the other day removed! This beats the one man and boy at the Nelson Column, that *Punch* talks about.

There is a tolerable sprinkling of sketches from abroad, by Messrs. G. P. Boyce, V. P. Sells, H. Jenkins, De Fleury, Druce, and others. Mr. W. Deane has made a very clever view of the "Interior of a Church at Capri, Bay of Naples" (1112),—Mr. Macquoid has two from Spain, viz., "The Doors of Toledo Cathedral" (1193), hung so high that the details, which seem curious, cannot be examined;—and (1218), "The Court of the Lions, Alhambra," very beautifully shown. The architecture is, of course, peculiar; the basins of the fountains have considerable elegance in outline. There are two views of Antwerp Cathedral; one by S. Read (1195), and the other by J. Chase (1220)—both very good; in the former especially, the Cathedral is perfectly detailed. Mr. L. J. Wood exhibits two charming little oil pictures of the Palais de Justice, Rouen (1240); and the Hotel de Ville, Ghent (1244). In (1194), we see a most elaborate elevation of Giotto's "Campanile de Florence" (F. Oliver), which, nevertheless, gives little idea of the real effect.—(We do not say this depreciatingly of the drawing.) "In 1332," as writes Lord Lindsay, "Giotto was chosen to erect it, on the ground, avowedly, of the universality of his talents;" and "the republic passed a decree that the Campanile should be built so as to exceed in magnificence, height, and excellence of workmanship, whatever in that kind had been achieved by the Greeks and the Romans in the time of their utmost power and greatness."

The few old English buildings that have been depicted it will suffice to enumerate:—Lichfield Cathedral, (1125); and York, (1191); Eltham Palace, (1184); Wooton Church, Gloucestershire, (1118); and the North Doorway of Stone Church, Kent, (1217); Tintern Abbey, (1119 and 1222); and Water-Gate Row, Chester, (1126).

We shall call attention to a few other drawings exhibited, of works in progress. We find (1165), Sir Joseph Paxton's "Entrance Court, Mentmore, Bucks, for the Baron M. A. Rothschild," which forms so striking an object in the landscape beyond Tring, on the North-Western Railway. The design is highly enriched Elizabethan of the "John Thorpe" school, and bears also unmistakeable sympathy with Wollaton Hall, near Nottingham. There is a touch of the severe in the exterior of what appears to be the sculpture gallery. "An Artist's Residence, near Windsor, E. G. Pennington" (1104), is, as it should be, picturesque; and the same may be said of (1107), a Mansion at Haverfordwest, by Coe and Goodwin, who also exhibit a view of another Mansion at Bridgenorth (1151), very elaborate, and revelling in Jacobean oddities. Mr. Andrews, whose former beautiful drawings of Somerleyton will be remembered, has a pretty view of the Winter-Garden there, designed by J. Thomas (1163). The architecture seems brought into too violent contact with the slender metal work and glass, and there seems an unsuitableness in the four-columned portico, besides its being heavy;—the glazed domes are well-managed, and very good-looking. "Somerleyton Village" (1120), a series of picturesque cottages and church, the whole designed, we believe, by Mr. Thomas, is the result of that generous liberality for which Mr. Peto is so distinguished. (1106), "Ince Blundell Hall, Lancashire, with the Intended Additions and Alterations, by J. J. Scoles," is a good Italian pile. Gelly Dêg, Carmarthenshire, by W. W. Jenkins (1122), is plain Italian of a very suburban character. Mr. P. C. Hardwick sends (1133), View of the Abbots-Sompting, Surrey, and (1180), Gardener's Cottage at Laverstoke House, both exhibiting considerable piquancy and good taste in design and in the materials chosen, with a strong feeling for the "continental." (1140), "Mansion near Erith, by J. Brooks," is every way the reverse. It has altogether a very poverty-stricken look, with unmeaning features, attenuated mouldings, and pimping battlements. (1203), "Mansion at Harrow, F. Barnes," is not much better. The alterations at Hooton Hall, Cheshire, by Mr. J. K. Colling (1225), are very excellent and judicious. We have only to refer our readers to the engraving in the present Number in corroboration of the opinion. In (1160), Tromer Lodge, Down, Kent, by J. Tarring, the most is made of a very commonplace affair. The tower is the best feature: it rises from the ground, having a circular turret at one corner, which corbels out into a square at the cornice level, and is carried up above the general parapet, finishing in a lead roof.

The "View of Almshouses about to be Erected at Tunbridge Wells" (1204), is better than the ordinary kind of building; the group is effective, and has many good points, showing attention to what are often deemed minor matters, and therefore unimportant, but which, in truth, are often the making or marring of a design. This holds good also with (1150), Mr. Talbot Bury's Almshouses at Lamborne, Berks, which has moreover a thoroughly quaint look; and we must commend the practice which we observe here, and on one or two other drawings, of giving little vignette sketches and plans in further elucidation of a subject.

There are one or two good designs for schools, particularly (1155), one for Cheltenham, by G. F. Bodley. Every detail in this evinces considerable taste and study, and there is an ingenious diversity in the several windows and chimneys. Effect is also gained by varied materials. Mr. Ferrey exhibits but one small drawing, which is of this class;—"Buildings of Brick, for Educational Purposes, in Ireland" (1238). They appear plain, and rather poor in design.

We recognise Mr. Hardwick again in (1161), "The Clergy Orphan School, Canterbury," an important building, which has the merit of, to a great degree, explaining externally the real arrangement. Still, we can scarcely call it a good architectural composition. The large four-light windows, both in the main and dormer gables, coming immediately on the head of puny single-lights, are too crushing, and the succession of these little lancets, which almost touch, and are continued along the whole front and wing of the building close under the eaves, is productive of a marked yet not happy effect. We understand they are to light a series of dormitories; but could not these have been differently planned?

The two drawings of cemeteries and cemetery chapels do not commend themselves to our good opinion. "The Lambeth Burial Ground at Tooting," by Wehnert and Ashdown (1209), is in the worst possible taste in every respect. "The Cemetery Chapels now erecting at Hanwell, by Mr. T. Allom" (1170), cannot be redeemed even by the pictorial talent of the artist.

"The Clock-Tower for the Market-Square, Geelong," designed by James Edmeston, jun. (1239), will attract attention from the novelty of the subject. We have ascertained the following particulars as to its construction. The materials are cast-iron, with terra-cotta and encaustic tiles introduced in the panels. These latter fill in the surfaces between the constructive skeleton, and also serve for varying the colours. None of the tiles are to be glazed. Wrought-iron is wholly avoided, so that there will be no necessity for galvanising, and it is so contrived that the whole will fit and hang together by means simply of sockets, dovetails, &c. The experience and skill of Messrs. Sylvester and Co., have greatly assisted in the practical working out of the design.

The show of churches this year is neither very great nor very good. The most important of these is, unquestionably, (1192), a "South-East View of St. George's Church, Doncaster, as now being rebuilt by Mr. G. G. Scott." This is a drawing which should certainly have been hung on the sight-line, were it only for the amount of beautiful detail it contains; as a picture, it has an unfinished look, and in the situation where it is placed is not so attractive as its merits deserve. Then we have Mr. P. C. Hardwick's "New Church at Deptford" (1134); an exceedingly good design, of "Decorated" character. The tower and spire are well proportioned, and have evidently been well studied. In the belfry-stage, the management of the two lights, having one label carried gable-fashion over both (which allows of a niche in the space thus inclosed), is very good. St. Mary's, Newark, may have suggested the idea. There is something odd about the base of the tower buttresses, which, just above the plinth, jut out sharply and without apparent reason. We observe the like in the other church which the same gentleman exhibits (1176), "Elstree, Herts, as Rebuilt" by him,—a plain, sensible-looking structure. Mr. Norton contributes several drawing;—(1187, 1189), Interior and Exterior of St. Andrew's Church, Somersetshire;" a very good design, only a little too laboured. In the nave-piers and font (which is very tasteful), marble shafts are introduced. (1246), a large church, "Erecting at Bedminster, Bristol," is by the same architect; and so is (1145), a nicely-coloured interior, taken across the building, of the Collegiate Church of Westbury-on-Trym, Gloucestershire, showing the restorations just completed. This seems a very creditable edifice, only that the array of poppyheads on the seats might have been dispensed with. They are uncommon in that part of England, nor do we ever like their appearance. Once more, in (1149), Mr. Norton exhibits a beautiful drawing of a simple Village Church,—Abertily, in the diocese of Llandaff; showing also the surrounding buildings, which include a double group of schools. The whole on a highly picturesque and favourable site.

Mr. E. W. Pugin's (1124) View of St. Mary's and St. Peter's Cathedral Churches, Shrewsbury, is very lofty and long drawn out: it has quite a foreign aspect. The smaller parts are indistinguishable, as, like several other drawings we have mentioned, it is hung too much above the eye. There is a nice Lychgate and Railing lately erected at Horsham, by Mr. Truefitt (1154), in that gentleman's usual taste. (1105) is Woolpit Church, Suffolk, showing the new tower and spire being erected from the designs of Mr. Phipson, of Ipswich. We confess to not liking this design at all. What authority has the architect for a stone spire in a locality where spires are rare in the extreme, and those old ones that do exist (and we fancy we remember such a one at Woolpit) are but little leaden ones a few feet high? The one he proposes to erect is excessively commonplace; and so are his alterations in the tower itself.

In 1177, 1181, and 1210, Mr. Raffles Brown exhibits views of the new church about to be erected at Old Brentford. This is altogether a very fair design, a little *outré* perhaps in such matters as very pointed windows with very short jambs, with very sloping buttresses, and a very slender spire. The doorway to the tower, which is well planned by filling in between the buttresses and forming a curtain wall, is as much too large as the clock-face just over is ridiculously small. We observe there is a double aisle on one side. (1159), Decorations of St. John's Church, Hawarden, Flintshire, R. P. Phillan, show a profusion of colour. . The large columns, which are painted like the "barber's pole," are perhaps the best. The wall diaper is objectionable, since the lozenges are coloured so as to appear sunk prismatically, instead of being surface work only. The pulpit is quite unworthy of the rest of the fittings, especially of the prayer desk, which, with its gigantic angels on each side, holding long tapers so high as to ensure a "dim" if not "religious" light below, is one of the most extravagant notions that can be conceived. Mr. Christian's "Interior of St. Luke's, Marylebone," (1227) is, as usual, cold and correct. The Decalogue &c., take the place of an east window, there being only a small circular one in the gable above, and this is treated spherically inside, to harmonise with the outline of the roof.

We have now gone carefully over our task, jotting down such notes as suggested themselves, and which in a more connected form we have laid before our readers. It remains only to take leave for the present, hoping that another year may bring about a change for the better, both in the character of our Architectural Exhibition, and the mode of its appreciation at the Royal Academy.

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The Directors of the West of England and South Wales District Banking Company, on the 19th of last month, decided on accepting for their new building at Bristol, the designs prepared jointly by Mr. W. B. Gingell, of Bristol, and Mr. T. R. Lysaght, of London, which is to be carried out under their superintendence. The premium of 50*l*. was awarded to Mr. E. M. Barry, of London; the premium of 30*l*. to Mr. J. Gibson, of London; and the premium of 20*l*. to Messrs. Gabriel and Hirst, of Bristol, for their designs. Upwards of fifty individuals submitted plans for competition.

## INSTITUTION OF CIVIL ENGINEERS.

*April* 25.—JAMES SIMPSON, Esq., President, in the Chair.

THE discussion being resumed on Mr. D. K. Clark's "Description of the Deep-Sea Fishing Steamer, *Enterprise*, with Ruthven's Propeller:" in allusion to the former experiments, it was shown that the power required for the propulsion of the *Enterprise*, at 9½ miles per hour, was 35 indicated horse-power, as estimated by Bourne's formula for resistance, founded on the results obtained by the *Rattler;* this power was nearly what was stated in the paper, (40-horse power,) with which also the stated consumption of fuel was in accordance.

It was argued, with respect to the supposed loss of power in communicating to the water the velocity of the vessel, that, inasmuch as the action of the propeller was in principle the same as if the intercepted water was raised to the height due to the velocity imparted to it, the velocity was only lent to the water, and ready, in virtue of that head, to be refunded when required; and that the necessary engine-power was equal to that which could raise the quantity of water required for propulsion, from the level of the sea to the height due to the velocity of efflux. On these principles, it was calculated from the data contained in the paper, that in the management of the water, exclusive of all frictional resistance, the ratio of power to effect was,

| | | | |
|---|---|---|---|
| The power used | = | 12·28 | horse-power |
| Ditto wasted . | = | 3·94 | ditto |
| Total . . | | 16·22 | ditto |

and it was concluded that there was much to be said in favour of Ruthven's mode of propulsion. The statements as to the former experiments were reiterated, viz., that the power required to communicate velocity to the water passed through the propeller, was not afterwards utilised. For, that assuming a ball to be suspended over the vessel, at a height due to the velocity of the vessel, and moving at the same rate, it was urged, that to raise the ball to that height, and to communicate to it the velocity, would obviously require just double the power necessary to raise it. Assuming the ball to be detached, it would descend vertically, as regarded the vessel, and would act upon it precisely as it would if both the ball and the vessel were at rest; as a consequence, therefore, it would only act with the effect due to the height from which it fell.

As another illustration, it was assumed that the deck of a vessel was level with the surface of the surrounding medium, and that a given portion of fluid was transferred from the medium to the level of the deck; then a certain amount of power would be expended in changing the condition of the water and imparting to it the velocity of the vessel; but as this water would only be at the level of the surrounding medium, it would not flow out again, and the power that had been absorbed would not be again utilised.

It was contended, that the inference from the experiments quoted, viz., that the pressure was double the hydraulic height due to the velocity, was incorrect; for the pressure was measured upon the reduced section of the "vena contracta," which was only five-eighths of the area of the real aperture, upon which area, as had been shown the unbalanced pressure should be estimated, and it was contended that the contrary inference led to inconsistent and anomalous results. But in no respect did these experiments apply to the case of water passing through a tube or pipe beyond the "vena contracta," as the area of unbalanced pressure would then be immediately reduced.

Referring to the experiment quoted in the paper, and assuming the possibility of the reaction pressure being equal to double the height due to the velocity, viz., 23 feet per second, *i. e.*, = $8\frac{6}{10}$ feet; then double that would = $17\frac{2}{10}$ feet + $\frac{9}{10}$ foot (the height of the issue above the sea) would give a total height of $18\frac{1}{10}$ feet; this × 25 feet (the quantity of water per second) and × into 60 (seconds per minute) and ÷ 528 feet (the quantity of water raised one foot high per minute, per horse-power) gave 51-horse power; then adding to that, the loss from the friction of the water in the passages, as stated in the paper, together with the friction of the engine itself, it would appear that the power applied must have been = 80-horse power instead of 40-horse power as stated, and thus showing that the experiment and the inference could not be reconciled.

Again, it was argued, that the useful effect was expressible, simply by the difference of the power consumed, in giving to the water the speed of the vessel and the power in expelling it; that, in the admission and in the expulsion of the water, reacting pressures, measured by twice the head due to the velocities of admission and expulsion, were exerted longitudinally upon the vessel, the difference of these reacting pressures expressing the useful effect. Putting V for the speed of the boat, and V′ for the effluent velocity of the water, with respect to the nozzles from which it issued; then the power expended being taken as unity, the useful effect was found to be represented by

$$2\,V\,\frac{V'-V}{V'^2}$$

which showed, that when the forward speed of the vessel and the effluent speed of the water were equal, there was no useful effect; and that the maximum useful effect was obtained when the effluent speed of the water was twice the speed of the vessel, and when the useful effect was just one-half of the power expended, exclusive of the friction resistance. Whereas, with the paddle or the screw, there did not appear theoretically, any limit to the ratio of the efficiency,—it might be equal to the power, —and in practice it was limited only by the extent of surface which it was convenient to give to the paddle-board or to the screw. Still, the amount of power obtained by the jet was less affected by deviations from the most useful velocity than in the case of the paddle or the screw; and there might be found to be practical advantages which would render the plan of the jet very advantageous in numerous cases.

With respect to the unbalanced pressure of reaction, by the flow of water through the side of a vessel at rest, it was argued that all attempts to explain the subject by reference to hydrostatic principles were fallacious, and that experiment alone could determine the results. Whitelaw, in his account of the reaction water-mill, had shown, by experiment, that the reaction was measured by the weight of a column of water of twice the head when the orifices were at rest.

A recent experiment on the reaction pressure was also described. A cylinder was fitted with a jet pipe in the side, at the bottom, of the form of the "vena contracta." It was suspended from a considerable height, so as to hang freely, and was filled with water, which was kept up to a constant level; when the water was permitted to flow out freely, an unbalanced pressure of one and a half the hydrostatic pressure under that head, was indicated on a balance, applied against the opposite side, as measured on the small section of the "vena contracta."

With respect to the formula, showing that the maximum useful effect was only-half the power expended, it was considered, that the conditions of the formula did not meet the case of a propeller, for it was assumed that the engine-power was available only for expelling the water, and that the mass of the vessel necessarily discharged the duty of taking up the water. Now, the facts were stated to be, that the machine not only discharged the water, but it also previously drew it into the vessel by exhaustion; and it was contended, that, under these circumstances, the maximum effect was obtained when the speed of the vessel was equal to that of the effluent water, and amounted to 100 per cent. of the engine-power, minus friction resistances.

In fine, though much difference of opinion was expressed as to the mode of action and the economy of Ruthven's propeller, it was agreed that in numerous situations the new propeller might be found to possess practical advantages over the paddle and the screw; and that the subject demanded further inquiry and investigation, theoretically and experimentally.

*May* 2.—The paper read, which was "*On Water-Meters,*" by Mr. David Chadwick (Salford), commenced by showing the long-experienced want of a good system of ascertaining the quantity of water delivered by water companies to private houses, public establishments or manufactories, direct from the pipes, without the intervention of cisterns, and under the varying pressures of high and low service, or under the circumstances of intermittent or constant supply. After alluding to the statement in the Reports of the Juries for the Exhibition of 1851 (Class V.), "that no instrument had hitherto been so far perfected, as to satisfy the conditions of a good meter;" the paper gave a list of the patented water-meters from 1824 to 1853, and then proceeded to explain succinctly the several systems hitherto employed under the several classifications of,—

1st. The Diaphragm principle.

2nd. The Water-wheel—the Turbine—the Spiral Fan—the Drum—and their various modifications.

3rd. The Piston and Cylinder.

Of the first-class, the machine of Mr. Parkinson appeared to have been most approved; but it was deficient in sensibility, was accompanied by a noise from the tumbling lever and weight, and was very liable to derangement from wear and tear.

The second class was the most numerous; and among the machines described were those of Mr. Taylor, Mr. Siemens, Messrs. Siemens and Adamson, and Captain Ericsson; which were considered the best. All these acted upon the principle of registering, by the pressure of the water against the vanes of a circular drum, or of a spiral screw, or of a fan. In practice they were all found to permit small quantities of water to pass continuously through the meter without registration, in consequence of a certain amount of force being required to overcome the resistance offered by those parts of the meter in connection with the counting apparatus, before motion could be given to it. An attempt had been made by Mr. Taylor to remedy this defect, by using a gutta-percha drum of the same specific gravity as water; but though the meter thus arranged measured correctly under full pressure, it varied much when either the inlet or the outlet pipe was partially closed. Mr. Siemen's inventions were well spoken of for their ingenuity, but the defect above mentioned equally applied to them. Captain Ericsson's rotary fluid meter was shown to bear a close resemblance to that of Mr. Taylor, and to be liable to the same objections. The reciprocating fluid meter, also by Captain Ericsson, was shown to have been used to some extent in the United States, and to be more effective in its action. Messrs. Donkin and Co's meter, on the principle of the disc engine, possessed a certain degree of merit, but it had not hitherto been rendered practically efficient.

The machines in ordinary use being generally defective, the want was in some degree supplied by the instrument introduced by Messrs. Hanson and Chadwick, of Salford, which was described by us last month in a paper read at the Society of Arts.

In the discussion many water meters were mentioned, and among them the various measuring machines introduced by Mr. Siemens were described, and it was shown that although a single screw suspended in a current of water might allow a considerable quantity of fluid to pass unmeasured, at low velocities, that defect had been counteracted by the addition of a second screw working in the opposite direction, and by a general equilibration of the working parts. That meters of this description had been found to measure water with great accuracy, at all speeds above one per cent. of the maximum speed; but had failed after working during a period of from six to fifteen months, in consequence of the inevitable abrasion of the spindles working under water. To obviate this serious difficulty, which applied equally to piston or to diaphragm meters, the more simple contrivance of a form analogous to that of a Barker's mill was adopted. The water entered the rotating disc of this meter through a contracted funnel, and spreading outward issued through tangential apertures into the surrounding casing. Inasmuch as the outlets would act to some extent in the manner of jets, this drum would revolve proportionately faster at high velocities, to counteract which upright blades were attached to the same revolving portion, giving a resistance in the water increasing as the square of the velocity. A uniform ratio within the limits of two per cent. was thus practically obtained. The only step or bearing of this meter was effectually protected from the water by forming a closed oil chamber at the bottom of the disc, into which there entered an upright stud with a steel point, abutting against a steel plate at the bottom of the chamber. In like manner the reducing wheels of the counter were enclosed in a sealed oil chamber. Out of three hundred meters on this plan, which had been in constant operation, under the most varied circumstances and pressures for about twelve months, not one had failed in the working parts. It was contended, that as the machine had ample power to overcome extraneous resistances, and as the friction had been reduced to a minimum, variations in that friction would not affect the measurement to any sensible degree. The advantages of this meter were its compactness, cheapness, and general applicability, either to waterworks purposes, or to measure the water pumped into steam boilers.

*May* 9.—The paper read was *"A Description of the Sliding Caisson at her Majesty's Dockyard, Keyham, Devon."* By W. Fairbairn, M. Inst. C.E.

The substitution of caissons for the ordinary lock-gates, and their employment for closing the wide entrances of docks, was first suggested in this country by Sir Samuel Bentham; since his time they appear to have been somewhat extensively used, although the objections of occupying a considerable time in having the water pumped out of them, and it being necessary to float them entirely away from the opening, before a vessel could pass, rendered them applicable only for special localities. The great width of opening required for the passage of ships of war, induced a rather general use of such caissons in the Royal Dockyards; and at the new dockyard at Keyham, where it was considered desirable to have the best accommodation for the newest class of large ships, the great breadth of the mouth and the depth of the basin, induced the trial of a new form and arrangement of caisson, which should be of such capacity and dimensions as to resist the pressure of the water, effectually close the entrance, and still be so easy of manipulation, as to admit vessels of war passing into the dock at any state of the tide.

The Keyham Docks were described as extending along the eastern shore of the Hamoaze, immediately below Morris Town; their construction was commenced in 1844, and they consisted principally of two capacious basins, with several entrances or locks from the sea; one of these it was thought desirable to construct in such a manner as to have the power of using it, when necessary, for a dry dock; its dimensions were 260 feet long, 80 feet wide, and 43 feet deep; the inner end, next the dock, was closed by a caisson of the ordinary form, and at the outer end, next the channel, the new caisson was tried. It was designed by Mr. W. Scamp, of the Admiralty, and was constructed by Mr. W. Fairbairn, by whom a description was transmitted to the Institution.

The form of the caisson was that of a rectangular vessel, 82 ft. 6 in. long at the top, 78 ft. 6 in. long at the bottom, 42 ft. high, and 13 ft. 6 in. wide; it was built of wrought-iron plates, varying in thickness from ⅞-inch at the bottom, to ⅜-inch at the top, well supported throughout by an inside framework of angle-iron and gusset-pieces, and by two decks of iron and one of timber for the interior arrangements, but which at the same time imparted great strength to the structure. The plates were connected by "butt-joints," with covering plates attached by double and quadruple rows of rivets, and at the bottom and ends were clothed with oak timber which bedded upon the cill, and against the jambs when the caisson was in its place. The internal arrangements of the caisson were such, that when it was required to withdraw it from across the opening of the lock, by merely opening a valve a sufficient quantity of water escaped from the upper chambers to allow the body to rise a few inches from the bottom cill, when instead of, as in the ordinary system turning it round and floating it away, it was drawn back by chains transversely into a channel or opening in the masonry, at right angles with the lock, leaving an opening of the clear span; and after the passage of the ship, it was drawn across again, and by opening another valve, as much water entered as settled it securely on its bed or cill. This operation was stated to have occupied only eighteen minutes for the passage of a line-of-battle ship, ten minutes for opening and eight minutes for closing. The total weight of the caisson was shown to be 290 tons; it contained 33 tons of iron ballast, and had an internal capacity for 323 tons of water. The mechanical arrangements were minutely described, and the general result appeared to have been very successful; and from the tabular statement of the deflection of the caisson, under the pressure of various depths of water, the structure appeared amply strong for resisting either the dead pressure, or the concussions of the waves which frequently beat heavily against the entrance of the docks.

*May* 16.—The Paper read was *"On the Fatigue, and consequent Fracture of Metals."* By F. Braithwaite, M. Inst. C.E.

Many accidenst, the causes of which have been pronounced "mysterious," having professionally engaged the author's attention, he had carefully examined the circumstances of each, and the condition of the fractured metal in all cases, and at length arrived at the conclusion that almost all the accidents might be ascribed to a progressive deteriorating action, which might be termed the "Fatigue" of metals.

Metal in a state of rest, although sustaining a heavy pressure or strain, as in a beam or girder, and exhibiting only the deflection due to the superposed weight, would continue to bear that pressure, without fracture, so long as its rest was not disturbed, and the same strain was not too frequently repeated; but if either of these cases occurred, a certain disturbance of the particles took place, the metal was deteriorated, and that portion subject to the reiterated strain was so far destroyed that it ultimately broke down. This might also arise from sudden concussions, when the metal was under a certain strain, and those concussions might be caused by the girder being suddenly unloaded.

Several examples were given of accidents of the kind that had been alluded to; for instance, that of a vat in a London brewery, carried on cast-iron girders, by which it had been supported for some years; but suddenly, without any apparent cause, they broke, and killed and wounded some workmen. In this case, it was shown that the girders were not originally sufficiently strong for the load, and therefore the intermittent load of the vat, which was sometimes full and at other times only partially so, and then empty, caused a constantly recurring deflection, and a subsequent corresponding effort to regain its natural position, by which the composition of the metal was disturbed, and fracture ensued.

Other examples of the same nature were given; and it was shown, that the repeated buckling of the tube-plate of a locomotive, arising from the action of the pistons, had a tendency to cause fracture mechanically; and also that the side-strains and vibrations to which the suspension-rods of the ash-pans of locomotives were subjected, had produced very serious results, which it sufficed to point out forcibly to guard against the recurrence of.

The author contended, that presuming adequate dimensions to have been given to girders, and the stipulated weight not to have been exceeded, the chances of accident were remote, but that any repeated deflection, either at intervals, or continued for so long as to induce a permanent depression, must be productive of danger, which could only be averted by altering or replacing the parts deficient in strength, and maintaining a rigid supervision, whether of beams when loaded, or of parts of machinery, or of railway stock after working. By such means, accidents would be prevented, and a greater degree of confidence be established in structures in which metal was employed.

*May* 23.—The paper *"On the Casualties of Tunnelling, with examples,'* by W. M. Peniston, M. Inst. C.E., was in reality a relation of the difficulties encountered in the formation of some tunnel headings through chalk and greensand, under a head of water at Holywell, on the line of the Wilts and Somerset Railway. The materials had been collected from the author's diary of the proceedings, and it had been his intention to give many more details, as practical examples for the younger members of the profession, but with access to the excellent work on 'Tunnelling,' by Mr. Simms, it was feared that the communication might be deemed too prolix. It was intended that No. 1 Tunnel should have been constructed in the usual manner, by sinking shafts, and connecting them by a bottom heading running through between open cuttings at the north and south ends; there were, however, indications from the borings of the ground being unfavourable, the body of the tunnel being in chalk full of faults, whilst the cuttings at both ends were in greensand, and copious springs showed themselves along the line of operations, which were conducted through strata generally dislocated, and not to be depended upon. In sinking the shafts, the water brought away with it such quantities of sand as to create cavities around and produce serious failures in the timbering, which required to be renewed and replaced several times. Numerous contrivances were essayed for overcoming the difficulties—gullets were cut at lower levels, in hopes of their drawing off the water, but the tenacity of the soil and the numerous faults precluded any chance of their being useful; nothing but incessant pumping could therefore be relied upon; but the consequence of this was that the framing of the shaft sunk bodily, until it was retained by a hanging kerbs and rod from the surface; then, in spite of close sheathing planks, a lateral settlement occurred, and amidst a recurrence of these accidents the shaft was carried down until the sand and water rose so rapidly in the bottom, that it was necessary to close it by a timber platform through which the water rose to a certain level, whence it was pumped. Similar difficulties were encountered in the other shafts, enhanced in the one case by the frequent recurrence of boulders of sandstone, which occasioned much loss of time and inconvenience in extracting them, and left large cavities behind the sheathing. The quantity of water also increased so much that the briefest delay in pumping obliged the men to leave the headings.

At length, it being observed that the dip of the sand-rock which was the water-bearing stratum, was in such a direction as to induce the inference that it might be used to convey the water away by having it tapped at a lower level, the attempt was made, and was attended with success. In the subsequent extension of the open cuttings, the numerous vertical faults were shown to have been, in a great degree, the cause of the slips in the shafts.

In consequence of observations on the saturated strata, it was determined to try the effect of a syphon, which was accordingly laid down; it was formed of cast-iron pipes six inches diameter, the short leg dipping into a hole at the bottom of one of the shafts, whilst the long leg extended through the crown heading and terminated in a cistern in the north cutting. By means of a hand-pump at the upper bend, the air was exhausted, and the action was so perfect as to drain the blocks of sand and enable the headings to be completed.

Accounts were given of numerous ingenious contrivances resorted to for overcoming difficulties, and also of the effects of the drainage upon the springs and wells in the neighbourhood. The various machines and devices employed were described in connection with all the tunnels; in fact, the paper was, as it professed to be, a detail of the casualties of tunnelling under circumstances of considerable difficulty, and it was well illustrated by a series of diagrams showing the works in all stages of their progress.

It was announced that the next meeting for the reading of papers would be held on November 14th, until which time the meeting was adjourned.

## THE ARCHITECTURAL INSTITUTE OF SCOTLAND.

The above Institute has resolved to hold an Architectural Exhibition in Glasgow, in December next, which, in addition to views, models, plans, and details of buildings, will embrace specimens of the various works of art and manufactures connected with architecture; such as carpets, furniture, tapestry, paintings, paperhangings, and all painted, carved, and sculptured decorations; painted, stained, and embossed glass; metallic castings, wrought-iron, &c.; marbles, mosaics, fountains, and vases; ornaments in porcelain, silver, cast and cut glass, &c.

We hope that the energetic efforts of this new Institute will be responded to by all interested in the dissemination of a correct taste in the arts of design amongst both manufacturers and the public in general.

## NEW PATENTS.

### PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAW AMENDMENT ACT.

*Dated December 15, 1853.*

2911. A. B. Callier, Paris — Improvements in the manufacture of umbrellas and parasols

*Dated January 25, 1854.*

187. J. Petrie, jun., Rochdale, Lancaster—Improvements in apparatus for drying wool after it has undergone the process of washing or scouring

*Dated February 10.*

322. W. Dray, Swan-lane—Improvements in the construction of portable farm and other buildings; part of which improvements are applicable to the construction of cart and wagon bodies and other structures

*Dated March 1.*

499. J. B. Gottung, Hawley-place, Kentish-town—Embroidering on leather for harness and other purposes. (A communication)

*Dated March 4.*

527. C. de Bergue, Dowgate-hill—Improvements in apparatus for bearing and buffing purposes

*Dated March 6.*

533. D. Barr, Sudbrook-park, Richmond—Improved combined hair brush and comb

*Dated March 8.*

549. J. C. Edington, Leicester-square—Working machinery for propelling vessels and firing guns

*Dated March 11.*

588. J. C. Hall, Monkwearmouth, Durham—Improved windlass
594. J. J. Aston, Middle Temple—Improvements in the construction of envelopes

*Dated March 15.*

616. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in heating apparatus. (A communication)

*Dated March 20.*

655. E. Esnouf, C. Mauger, jun., and G. W. Lewis, Jersey—Improvements in portable dwellings and vehicles for travellers or emigrants

*Dated March 24.*

695. J. Jeyes, Northampton—Manufacture of pulp from twitch or couch grass

*Dated March 28.*

712. J. Woodward, Acton-street—Apparatus for stopping shot and other holes in ships and vessels
714. A. Hodgkinson, Springfield Bleach Works, Belfast—Improvements in bleaching linen fabrics
716. H. Francis, West Strand—Improvements in machinery for crushing, grinding, washing, and amalgamating quartz, and other matters containing gold or silver
718. F. Chambon and A. Meyniac, Chaylard, France—Improvements in bleaching or scouring silk
720. E. Rowland and J. Rowland, Manchester—Improvements in the manufacture of certain metallic springs

*Dated March 29.*

722. C. Barlow, Chancery-lane—Improvements in the permanent way of railways. (A communication)

*Dated March 31.*

738. J. M. G. Coste, Passy, near Paris—Revivifying animal charcoal that has already been used, and obtaining by a peculiar process prussiate of potass or soda from it
739. A. D. Brown, Glasgow—Improvements in beds, couches, and other articles of furniture
740. H. Homewood and J. Gregory, Mount-street, Lambeth—Improved fire-escape
741. A. A. Reginald Hely, Cannon-row, Westminster—Improvements applicable in exhibiting artistical, natural, or other objects, on a large scale
742. W. E. Newton, Chancery-lane—Improved manufacture of carpet. (A communication)
743. A. V. Newton, Chancery-lane—Improved mode of manufacturing carpets

*Dated April 1.*

745. F. S. Thomas, Cornhill, and Hook's-villa, Fulham—Improvements in locomotive engines
747. Sir R. J. Clifton, Clifton-hall, Nottingham—Improved percussion-shell
749. A. E. L. Bellford, Castle-street, Holborn—New and useful fabric for boot and shoe soles, machine banding, and other purposes. (A communication)
751. W. Johnson, Lincoln's-inn-fields—Improvements in the treatment or reduction of metallic ores and salts. (A communication)
753. W. Smith, Witney, Oxford—Improved mop
755. W. Kestall, Burnham, Berks—Improvement in fixing or cementing glass to metal

*Dated April 3.*

757. T. Scott, Brighton—Improvements in machinery for propelling
758. J. Forsyth, Caldbeck, Cumberland—Improvements in machinery for preparing and spinning wool and other fibrous substances
759. P. A. F. Bobœuf, Castle-street, Holborn—Application of electricity and fixed or moveable ærostation to military strategy and pyrotechny
760. W. Ashdown, Piccadilly—Improvements in gas-stoves
761. R. E. Hodges, Southampton-row, Russell-square—Improvements in connecting wheels, drums, cylinders, and pulleys with their naves, axes, and the parts thereof one to the other
762. W. Gossage, Widnes, Lancaster—Improvements in the manufacture of certain kinds of soap
763. G. Devincenzi, Grosvenor-street—Improvements in producing ornamental and figured surfaces, and surfaces for printing from, also the hardening or preparing of certain objects to be employed in the process
764. C. Walker, Bury, Lancaster—Improvements in steam-engines, and in apparatus applicable to safety-valves for steam-boilers

*Dated April 4.*

765. J. Gurney, Bradford, York—Improvement in machinery or apparatus for spinning wool and other fibrous materials
766. J. Higgin, Manchester—Improvements in the mode or method of separating metals from each other when in conjunction, and in obtaining useful products therefrom
767. J. Swarbrick, Baxenden, Lancaster—Improvements in steam-boilers
768. J. Bentley, Liverpool—Improvements in breech-loading fire-arms
769. H. Seebohm, Bradford, York—Improvements in preparing and combing wool, goats' hair, alpaca, cotton, and other fibrous material
770. G. S. Parkinson, Westbourne-park-road—Improvements in railway-breaks
771. B. Samuelson, Banbury, Oxford—Improvements in machinery for cutting turnips and other vegetable substances
772. R. Brisco, Low Mill-house, St. Bees, and P. S. Horsman, St. John Beckermet, Cumberland—Improvements in heckling machinery
773. H. Y. D. Scott, Queen's-terrace, Woolwich—Improved mode of manufacturing cement
774. A. V. Newton, Chancery-lane — Improved machinery for raising and forcing fluids. (A communication)
775. F. G. B. Capouillet, Brussels—Improved apparatus for generating heat by the combustion of bituminous or resinous substances. (A communication)
776. J. E. McConnell, Wolverton, Buckingham—Improvements in wheels, axle-boxes, and breaks for railway carriages
777. J. H. Glassford, Glasgow — Improvements in lithographic and zincographic printing

*Dated April 5.*

778. H. Blatter, Paris—Improved mode of constructing thermometers
779. W. Gilpin, Moorgate-street—Improvements in electrical communication
780. G. Ross, Falcon-square—Improved mode of preventing the alteration of bank-bills from one denomination to another. (A communication)
781. W. E. Newton, Chancery-lane—Improved apparatus for printing piece goods or fabrics. (A communication)
783. C. Bekaert, Paris—Improvements in machinery for doubling, twisting, and winding flax, silk, cotton, hemp, wool, and other fibrous substances. (A communication)
784. J. Harlow, Birmingham—Improvements in the manufacture of metal bedsteads
785. S. Smith, Hanover-terrace, Bristol—Improvements in vessels and apparatus used for raising sunken vessels and other bodies in the water, and for lowering materials for structural purposes in water
786. G. F. Wilson and J. M. Whiting, Rhode Island, U. S.—Improvements in the manufacture of wood screws
787. W. R. Gillard, Kirby-street—Improved method of colouring and ornamenting leather, vellum, book-edges, paper, and other like substances employed in bookbinding

*Dated April 6.*

788. J. Weston, Norwood—Improvements in transmitting and applying motive power for propelling railway-trains, ships' boats, barges, and such like vessels, and for other useful and mechanical purposes
789. J. Smith, St. Leonard's-on-Sea, Sussex—Improvements in the construction of railways
790. W. G. Craig, Newport, Monmouthshire—Improved mode of making communications between the commander and the engineer or the helmsman, or other person on ship-board

91. C. de Bergue, Dowgate-hill—Apparatus for acting on water and other liquid, so as to force, displace, or propel the same, or a body floating thereon
792. J. Nash, Thames-parade, Pimlico—Manufacture and refining of sugar
793. S. O'Regan, Liverpool — Improvements in engine-boiler furnaces and other furnaces
794. A. E. L. Bellford, Castle-street, Holborn—Improvements in sewing-machines. (A communication)
795. J. E. Boyd, Lewisham—Improvements in the construction of ships' anchors
796. E. Dupont, Boulogne-sur-Mer, France—Improvements in the manufacture of certain cements
797. J. Yule, Port Dundas-road, Glasgow—Improvements in the machinery for raising minerals from mines
798. J. Chance, Davies-street, Berkeley-square—Improvement in the manufacture of ribs of umbrellas and parasols, and of busks and substitutes for bones of stays and dresses
799. A. V. Newton, Chancery-lane—Improvements in the construction of hot-air engines. (A communication)
800. J. Bernard, Club-chambers, Regent-street — Improved mode of stitching, or uniting and ornamenting various materials, and in machinery or apparatus for the said purpose
801. J. Worrall, jun., Salford, Lancaster—Improvements in the method of bleaching fustians and other textile fabrics, and in the machinery or apparatus connected therewith
802. J. H. Johnson, Lincoln's-inn-fields—Revolving, blowing, and ventilating water-extractor for drying cloth. (A communication from T. F. King, New York)
803. W. Richards, Barcelona, Spain—Improvements in wet gas-meters

*Dated April 7.*

804. T. Williams, Manchester, and S. Ainley and M. Mills, Oldham—Improvements in machinery or apparatus for spinning cotton, wool, flax, or other fibrous materials
805. A. Tylor, Warwick-lane—Improvements in moderator-lamps. (A communication)
806. H. Moss, Mansfield-street, Cavendish-square—Auriferous quartz washing, pulverising, crushing, separating, and amalgamating machine
807. F. R. A. Glover, Bury-street, Westminster — Improvements in two-wheeled carriages
808. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in the preparation of photographic paper. (A communication)
809. L. F. Saugrin, Paris—Improvements in the construction of stereoscopes
810. R. Harling, Clerkenwell—Mechanical arrangements for multiplying power
811. J. Jopling, Bishopwearmouth, Durham—Improvements in preserving the tuyere used for blowing in forge and other furnaces from the action of the fire
812. W. H. Bentley, Bedford—Improvements in irrigators or machines for watering grass and other lands, roads, floors, flowers, plants, shrubs, and trees, and applicable for all purposes for which ordinary watering-pots are employed; parts of which improvements are also applicable to pumps for raising and forcing liquids
813. T. Wood, Ramford-street, Oxford-street, Manchester—Improvements in centrifugal machines
814. J. Rankin, Liverpool—Improvements in machinery for cleaning corn and seed
815. H. B. Condy, Battersea—Improvements in concentrating beer, ale, cyder, wine, and vinegar
816. J. E. Wilson, Great George-street, Westminster—Improvements in the construction of iron girders
817. J. R. Johnson, Stanbrook-cottage, Hammersmith—Improvements in the manufacture of type and other raised surfaces for printing
818. J. H. Johnson, Lincoln's-inn-fields—Alkaline steam-washing apparatus. (A communication from T. F. King, New York)
819. W. Rigby, Manchester—Improvements in machinery or apparatus for engraving metallic cylinders or rollers, employed for printing calico and other surfaces
820. W. Naylor, Norwich—Improvements in locomotive engines
821. W. Naylor, Norwich—Improvements in power-hammers
822. W. E. Newton, Chancery-lane—Improvements in producing stereoscopic pictures, and in the apparatus for exhibiting such or similar pictures. (A communication)
823. T. Whitehead, Leeds—Improvements in machinery for preparing, combing, drawing, and spinning wool, flax, cotton, silk, and other fibrous substances
824. J. Corlett, Luimbres, France—Improved machinery for preparing or scutching flax and other fibrous materials requiring such an operation. (A communication from B. Delatre, Setques, France)
825. A. V. Newton, Chancery-lane—Improvements applicable to the manufacture of weavers' harness. (A communication)

*Dated April 8.*

826. T. Bromley, Liverpool—Improvements in the manufacture of soap
829. W. Worby, Ipswich—Improvements in machinery or apparatus for separating grain from straws, broken-off ears, husks, and other refuse, after being thrashed
830. W. Williams, Park-cottage, Ebbw Vale, and T. E. Williams, Abersychan Ironworks, near Pontypool, Monmouth—Improvements in reverberatory furnaces
831. C. B. Clough, Tyddyn Mold, Flint—Improvements in the manufacture of coffins
832. W. C. Most, Strand—Machine for crushing, pulverising, and amalgamating
833. G. Savage, Stoke-Bruen, Northampton—Improvements in the manufacture of bricks and roofing tiles
834. H. Gilbee, South-street, Finsbury—Improvements in the construction of axle-boxes and axle-bearings. (A communication)

*Dated April 10.*

836. W. Wood, Monkhill-house, Pontefract, York—Improvements in treating animal matters and refuse
837. W. Wood, Monkhill-house, Pontefract, York—Improvements in apparatus employed in the manufacture of cut pile fabrics
838. A. S. Bolton and F. S. Bolton, Birmingham—Improvement or improvements in the construction of steam-boilers
839. A. S. Bolton and F. S Bolton, Birmingham—New or improved method of manufacturing certain kinds of metallic tubes
840. F. L. Bauwens, Pimlico—Improvements in distilling fatty bodies, and in stills or apparatus for such distillation
841. W. L. Baker, Hargreave, Northampton—Improvements in clock, tower, turret, and other like bells

*Dated April 11.*

842. R. A. Brooman, Fleet-street—Improvements in the manufacture of hats. (A communication)
843. Z. Round, Dudley, Worcester—Improvement or improvements in bricks to be used in certain parts of buildings
844. W. E. Brooks, Queen-street—Improvements in valves for atmospheric railway tubes
845. M. Lavender, Princes-road, Bermondsey—Improvements in apparatus for stirring and acting on matters subjected to heat in retorts
847. C. A. Noedl, Upper St. Martin's-lane—Portable vapour-bath
848. J Mitchell, Dunning's-alley, Bishopsgate-street—Improvements in machinery for pulverising, grinding, amalgamating, and washing ores
849. J. J. Peile, Whitehaven, Cumberland—Improved construction of lifting-jack
851. U. Scott, Camden-town—Improvements in the adaptation of elastic material to boots and shoes, and shoes for horses and other animals
852. J. Miller, jun,, and M. Burke, Liverpool—Improvements in machinery for transmitting motive power
853. T. Carr, Liverpool—Improvements in steering apparatus
854. B. Fothergill and W. Weild, Manchester—Improvements in machinery for combing cotton, wool, flax, silk, and other fibrous materials
855. W. H. James, Camberwell—Improvements in marine and other structures

*Dated April 12.*

856. L. Cruger, Washington, U. S.—New and improved mode of attaching propellers to ships and vessels of all classes. (A communication)
857. E. Briggs, Castleton Mills, near Rochdale, Lancaster—Improvements in machinery and apparatus for finishing yarn and thread
858. R. Whiteside, Egremont, Birkenhead—Improvements in treating or purifying wheat and other grain
859. W. Coltman, High-street, Leicester—Improvement in knitting-frames
860. J. Piper, Shoreditch—Improvements in apparatus for affixing adhesive stamps and labels
861. S. Colt, Spring-gardens—Improved machinery for cutting or shaping metals. (Partly a communication)
862. G. Letts, Northampton—Improved mole-trap

*Dated April 13.*

863. S. B. Parker, Deptford—Improved apparatus for consuming smoke
864. E. W. Hansen, Saxe Gotha—Electro-magnetic engraving machine
865. G. Elliot, St. Helen's, Lancaster—Improvements in the manufacture of carbonate of soda
866. A. H. Cox, Ship-street, Brighton—Improvements in coating pills and boluses
867. J. Greenwood, Irwell Springs, near Bacup, and R. Smith, Bacup—Improvements in sizeing, stiffening, and finishing textile materials or fabrics
868. G. Devincenzi, Grosvenor-street—Method or methods of producing engraved, figured, and typographic surfaces for printing and embossing from, and for ornaments; also certain machinery employed therein

*Dated April 15.*

869. J. Griffiths, Moorgate-street—Improved portable measuring instrument
871. H. Meyer, Manchester—Improvements in looms for weaving
872. J. Croisy, Paris—Improvements in machinery for manufacturing bolts, rivets, screw-blanks, railway-pins, and other similar articles
873. T. Lawes, City-road—Improvements in protectors for the head. (A communication)
875. A. Chaplin, Glasgow—Improvements in the application of cast-iron to building purposes
876. P. A. Lecomte de Fontainemoreau—Improvements in priming fire-arms. (A communication).
877. F. Barnett, Caroline-street, Bedford-square — Illuminated furniture, &c., for interior and exterior decoration
878. A. E. L. Bellford, Castle-street, Holborn—Improvements in the manufacture of steel and wrought-iron directly from the ore. (A communication)
879. G. L. F. Tiret, Paris—Improved canvas for embroidering

*Dated April 17.*

880. G. Heyes, Aspull, near Wigan, Lancaster—Improvements in the method of arranging and constructing the gearing or driving-apparatus of machinery, to prevent accidents, and save time and expense in arranging the same
881. T. Hawkins, Northfleet, Kent—Apparatus for creating an upward draught or current of air in chimneys; which apparatus is also applicable to the purposes of ventilation
882. W. Wilkinson, Nottingham—Improvements in the method of and machinery for manufacturing ropes and cords
883. W. H. Bentley, Bedford—Improvements in cannons, guns, and other fire-arms, and in projectiles for the same.
884. B. Fullwood, Bermondsey—Improvements in the manufacture of cement
885. J. A. Smith, Edinburgh—Improvements in the manufacture of explosive projectiles
886. D. Tannahill, Glasgow—Improvements in lithographic and zincographic printing

*Dated April 18.*

887. C. C. Davis, Bath—Improvements in portable blow-pipe apparatus
888. S. Healey, Over Darwen, near Blackburn, Lancaster—Improvements in apparatus applicable to steam-boilers for preventing explosions and saving fuel
889. C. Meason, Warrington, Lancaster—Improvements in supplying fuel and water to locomotive engines, or to the tenders of locomotive engines
890. J. Bernard, Club-chambers, Regent-street—Improvements in the manufacture of boots and shoes, and in the machinery or apparatus connected therewith
891. J. Bernard, Club-chambers, Regent-street—Improvements in stitching, and in machinery and apparatus connected therewith
893. C. Watt, Gloucester-gardens, Gloucester-place, Kentish-town—Improvements in bleaching hemp, flax, and other fibrous substances
894. H. H. Gibbs, Bishopsgate-street—Improvements in the manufacture of nitrate of soda. (A communication from P. Gamboni)
895. J. Frearson, Smethwick—Improvements in steam-engines
896. W. Denton, Addingham, York—Improvements in combing wool and other fibres
897. J. F. F. Challeton, Brughat, France—Machinery for purifying and condensing peat, and also for conveying it

*Dated April 19.*

898. J. D. Pfeiffer, Paris—Improvements in bookbinding
899. M. Poole, Avenue-road, Regent's-park—Improvements in drying and weighing fibrous and other substances. (A communication)
900. J. Kirkham, Tonbridge-place—Improved means of consuming smoke in furnaces
901. J. C. Haddan, Chelsea—Improvements in adhesive stamps and labels
902. J. Jeyes, Northampton—Improvements in the manufacture of pulp suitable for paper-making.
903. J. Briggs, Derby—Means of communicating intelligence from one part of a railway train to another
904. H. Clarke, Lincoln—Improvements in cannons, guns and other fire-arms
905. R. A. Brooman, Fleet-street—Improvements in separating substances of different specific gravities, and in machinery employed therein. (A communication)

*Dated April 20.*

906. T. Vickers, Manchester—Improvements in the manufacture of manure
907. E. Hunt, Walcot-square Kennington-road—Improvements in treating minerals for the extraction of their valuable metals
908. R. Richardson, Great George-street, Westminster—Improved method of joining or securing the joints of pipes
909. J. Pym, Bangor, Carnarvon—Improvements in the manufacture of pipes for the transmission of water and other fluids
910. H. Brown, Halifax, York — Improvements in combing wool, hair, cotton, and other fibrous materials
911. J. M. Reed, Northumberland-street, Strand—Improvements in the treatment of amalgams
912. G. Jones, Sedgley, Stafford—Improvements in landing apparatus to be used in working mines
913. W. Johnson, Lincoln's-inn-fields—Improvements in machinery or apparatus for making bricks or tiles. (A communication from M. A. Julienne, Paris)
914. W. Johnson, Lincoln's-inn-fields—Improved apparatus for discovering the leakage or escape of gas. (A communication from E. A. Maccaud, Paris)

*Dated April 21.*

915. T. Wood and S. H. Heginbotham, Culcheth, Lancaster—Improvements in metallic pistons for steam-engines and pumps
916. F. B. Anderson, Gravesend—Improvements in spectacles and eye-glasses
917. R. J. Crickmer and F. W. Crickmer, Bermondsey—Improvements in cannons and field-pieces
918. C. Cammell, Sheffield—Improvements in the permanent way of railways
919. R. H. Collyer, Norfolk-street, Strand—Improved machinery for crushing or triturating hard substances
920. W. Harcourt and J. Harcourt, Birmingham—Improvements in chamber or flat-bottomed candlesticks
921. S. Minshull and C. Austin, Birmingham—Improvements in securing and fastening the lids of boxes or cases used for packing manufactured or other goods
922. W. B. Stephens, Mark-lane—Improvements in lamps. (A communication)
923. A. Blavier, Chemin-de-fer de l'Ouest, Boulevard Mont Parnasse, Paris—Improvements in locomotive engines

*Dated April 22.*

924. H. B. Barlow, Manchester—Improvements in manufacturing metal nuts, and in machinery for stamping, forging, and punching the same. (A communication)
925. P. J. F. Mouchell, Paris—Improvements in melting, and in treating the ores and metals
926. J. Harlow, Moseley, Worcester—Improvements in the manufacture of paper, pasteboard, and millboard
927. T. F. Finch, Lidbury-street, Worcester—Improvements in the manufacture of buttons
928. J. Gill, Marsala, Two Sicilies—Improvements in apparatus for the distillation of spirituous liquors
929. R. Galloway, Lambeth—Improvements in the construction of furnaces
930. W. Goodchap, Walbrook-house, Walbrook—Improvements in obtaining power by carbonic acid gas. (A communication from H. Greenfield, New Orleans)
931. J. Warren, Old Broad-street—Improvements in the construction of railways

*Dated April 24.*

932. C. E. Blank, Trump-street—Improvements in winding or reeling yarn into hanks. (A communication)
933. D. Buddo, St. Andrew, Fifeshire—Magnetic weather-gauge, to give warning of the approach of gales and storms, &c.
934. C. Hart, Wantage, Berkshire—Improvement in the mode of applying power to combined threshing and dressing machines
935. M. Poole, Avenue-road, Regent's-park—Improvements in washing garments and fabrics. (A communication)
936. J. Wilson, Croydon—Improvements in the construction of portable houses and other buildings
937. W. E. Newton, Chancery-lane—Improved machinery for casting type. (A communication)
938. J. Combe, Belfast—Improvements in machinery for heckling flax and other fibrous substances
939. W. E. Newton, Chancery-lane—Application of a new or improved material or substance to the construction of certain parts of machinery. (A communication)
940. T. W. Dodds, Rotherham, York—Improvements in furnaces and fireplaces for effecting a more perfect combustion of fuel and prevention of smoke
941. J. Davidson, Edinburgh—Improvements in breakwaters
942. W. Blackwood, Arthurlie, Renfrew—Improvements in the treatment and finishing of threads or yarns

*Dated April 25.*

943. R. F. Sturges, Birmingham—Improvement or improvements in joining metals
944. F. L. H. Danchell, Acton—Improvements in obtaining and applying motive power
945. F. A. T. de Beauregard, Paris—Improvements in the manufacture of inks, and in the preparation of papers for receiving the same
946. W. Collier, Weston, Chester—Improvements in evaporating-pans for concentrating solutions of certain acids, alkalies, and salts
947. R. Ellis, and J. W. Martin, St. James's, Westminster—Improvements in the mode of drying or desiccating by the agency of atmospheric air
948. J. Aitken, Douglas, Lanark—Improvements in sawing machinery
949. J. Lawson and S. Dear, Leeds—Improvements in looms for weaving
950. J. Goucher, Worksop, Nottingham—Improvements in propelling ships and other vessels

*Dated April 27.*

951. C. Person, Paris—Improvements in coating with zinc by galvanisation
952. E. Crossland, Rochdale, and T. Boardman, Westhoughton, Lancaster—Improvements in weaving, and in machinery for manufacturing cut pile and other fabrics
953. T. G. Owen, Shrubland-road, Dalston—Improved construction of portable filter
954. W. Gravatt, Park-street, Westminster—Improvement in propelling ships and other vessels
955. J. H. Johnson, Lincoln's-inn-fields—Improvements in revolving fire-arms. (A communication).
956. J. H. Johnson, Lincoln's-inn-fields—Improvements in polishing and flattening metal plates. (A communication from H. Beaud, Paris)
957. Sir G. R. Farmer, Bideford, Devon—Improvements in safety-valves for steam-boilers
958. H. Clarke, Lincoln—Improvements in fire-arms and ordnance
959. R. Green, Sydney-street, Brompton—Improvements in propelling vessels
960. J. Barling, High-street, Maidstone—Improvements in treating the hop-bine, and rendering it applicable to the manufacture of paper and other articles.
961. F. Woodbridge, Green's-terrace, Lower-road, Rotherhithe—Improvements in furnaces

*Dated April 28.*

962. A. W. Gibson, Edinburgh—Improvements in mills for the manufacture of barley and rice
963. W. L. Tizard, Aldgate—Apparatus for roasting and calcining ores and minerals, and separating metals therefrom, which apparatus is in whole or in part applicable to the drying and roasting of malt and other vegetable substances
964. J. Evans, Abbots Langley, Hertford—New manufacture of paper
965. J. Heywood, Ratcliffe-bridge, Lancaster—Improvements in machinery or apparatus for printing yarns

*Dated April 29.*

966. A. M. Dix, Salford, Lancaster—Improvements in apparatus for regulating or governing the supply or pressure of gas as it is conducted from the main to the burners
967. B. Dixon, Birmingham—Improvement or improvements in the joints of measuring-rules
968. J. P. Varlet, Paris—Improvements in obstructing the holes produced by accidents or projectiles in the hulls of ships and boats

*Dated May 1.*

970. J. Porter, Salford, Lancaster, and R. Howson, Manchester—Improvements in forge-hammers
971. E. Briggs and W. Souter, Rochdale, Lancaster—Improvements in treating and preparing silk, and in machinery connected therewith
974. W. Macfarlane, Glasgow—Improvements in waterclosets, lavatories, dust-bins, and public and domestic conveniences.
975. J. Fenton, Low Moor, Bradford, York—Improvements in safety-valves
976. J. Hamilton, New York—Improvements in machinery for crushing quartz and other substances
977. W. R. Palmer, New York—Improvements in the construction of spike threshing-machines, whereby all liability to, and danger of, accident in their use is removed and prevented, and by which the grain is cleansed from chaff, smut, &c., at the same it is being threshed
978. J. Clarke, Leicester—Improvements in knitting machinery

*Dated May 2.*

981. J. Mayer, Burslem, Stafford, and J. D. Kind, Birmingham—Improvement or improvements in attaching door-plates, letters, and figures made of glass, porcelain, earthenware, or other vitreous or semi-vitreous substance to doors and such other surfaces as the same may be required to be attached to
982. A. Truman, Swansea, Glamorgan—Improvements in the manufacture of sulphuric acid when roasting copper ores, and also when burning sulphur or iron pyrites
983. R. Waller, Leeds—Improvements in valves applicable to steam-engines and other purposes, and in apparatus connected with the same
984. W. E. Newton, Chancery-lane—Improvements in moulding, preparing, and finishing articles and fabrics made of compounds of caoutchouc, gutta-percha, and other substances. (A communication)
985. C. Minasi, Brecknock-place, Camden-town—Improvements in apparatus for hatching eggs, and for raising or rearing the young when first produced
987. G. Die, Paris—Improvements in the manufacture of tracing-cloths and tracing-paper
988. D. Plisson, Paris—Improvements in chemical condensing apparatus
989. L. Gluckman, Sackville-street, Dublin—Improvements in effecting electric communications in railway trains and vessels
990. B. Bishop and J. Dyer, Birmingham—Improvements in the manufacture of stop-butts and other hinges

*Dated May 3.*

991. T. Main, Glasgow—Improvements in steam-engines
992. J. H. Johnson, Lincoln's-inn-fields—Improvements in lathes for turning wood and other materials. (A communication from A. Warth, New York)
993. W. W. Richards, Birmingham—Improvement or improvements in loading certain kinds of fire-arms
994. A. E. L. Bellford, Castle-street, Holborn—Improvements in grinding-mills. (A communication)
995. E. H. Rascol, Catherine-street, Strand—Improved connection for driving straps, bands, or belts. (A communication from Mdlle. M. Convents, Nancy, France)
996. M. Poole, Avenue-road, Regent's-park—Improvements in paving or covering the surfaces of roads, streets, or ways. (A communication)
997. W. H. Knapp, Cross-street, Islington—Improvements in the manufacture of hats and bonnets

*Dated May 4.*

999. E. Barlow, Bolton-le-Moors, Lancaster, W. Johnson, Farnworth, Lancaster, and W. Slater and P. Knowles, Bolton-le-Moors, Lancaster—Improvements in machinery for preparing and spinning cotton and other fibrous materials
1001. J. Nasmyth, Patricroft, near Manchester—Improvement in the process of puddling iron

*Dated May 5.*

1003. H. Stewart, Baker-street, Bedford-square—Pocket-protector and pocket
1005. F. C. Hills, Deptford—Improvements in the means of preventing or consuming smoke in furnaces
1007. A. G. A. Martin and C. Lefol, Paris—Improvements in the manufacture of iron wheels
1009. J. Wonfor, Bridge-street, Blackfriars — Improvements in the manufacture of manure
1011. V. Wanostrocht, Great Tower-street — Improvements in the construction of cannon, and in projectiles to be used therewith. (A communication)

*Dated May 6.*

1012. T. W. Gibson, Thomas-street, Stamford-street—New beverage, intended to be called "Gibson's pinerium, or aerated sarsparilla"
1013. E. J. M. Archdeacon, Walworth—Improved book-mark or index
1014. B. J. La Mothe, New York—Improvements in the construction of buildings
1015. J. G. Jennings, Great Charlotte-street, Blackfriars—Improvements in the manufacture of earthenware pipes for drains and sewers
1016. B. J. La Mothe, New York—Improvements in the construction of railroad cars
1017. J. G. Jennings, Great Charlotte-street, Blackfriars—Improvements in apparatus for regulating and supplying water for waterclosets and other purposes
1018. H. G. Drewe, Paddington—Improvements in obtaining metal from ores
1019. R. Waller, Leeds—Improvements in engines and apparatus, and means of obtaining motive power from liquids, vapours, gases, or air; parts of which invention may be applied also to ordinary steam or other engines
1021. C. Cammell, Sheffield—Improvements in buffer, draw, and bearing springs for railway carriages, and in the mode of or apparatus for making the same
1023. J. H. Higginbotham, Ashby-de-la-Zouch, Leicester—Improvements in the valves and apparatus connected with waterclosets; certain portions of which are applicable as cocks or valves for other purposes

*Dated May 8.*

1025. J. Jefferis, Grove, Southwark—Improvements in packing for pistons, piston-rods pumps, joints of pipes, and other like purposes
1027. H. M. Naylor, Birmingham—New or improved instrument for cutting various articles of food
1029. G. B. Goodman, Salisbury-place, New-road—Improvements in apparatus for holding together letters, music, and other loose sheets. (A communication)
1031. T. Lemielle, Bruxelles, Belgium—Improved apparatus applicable to the ventilation of mines, buildings, and other places

*Dated May 9.*

1033. W. B. Adams, Adam-street, Adelphi—Improvements in rails for railways, and modes of connecting and fixing them
1035. C. Liddell, Abingdon-street, Westminster—Improvements in moving boats on canals and rivers
1037. A. V. Newton, Chancery-lane—Improvements in the manufacture of artificial stone for building and other purposes. (A communication)

*Dated May 10.*

1039. W. C. Fuller, Bucklersbury, Cheapside—Improvements in the adaptation of india-rubber springs
1043. W. Williams, Dublin—Improved propeller
1045. J. Lawson, Glasgow—Improvements in drawing ships out of water. (A communication)

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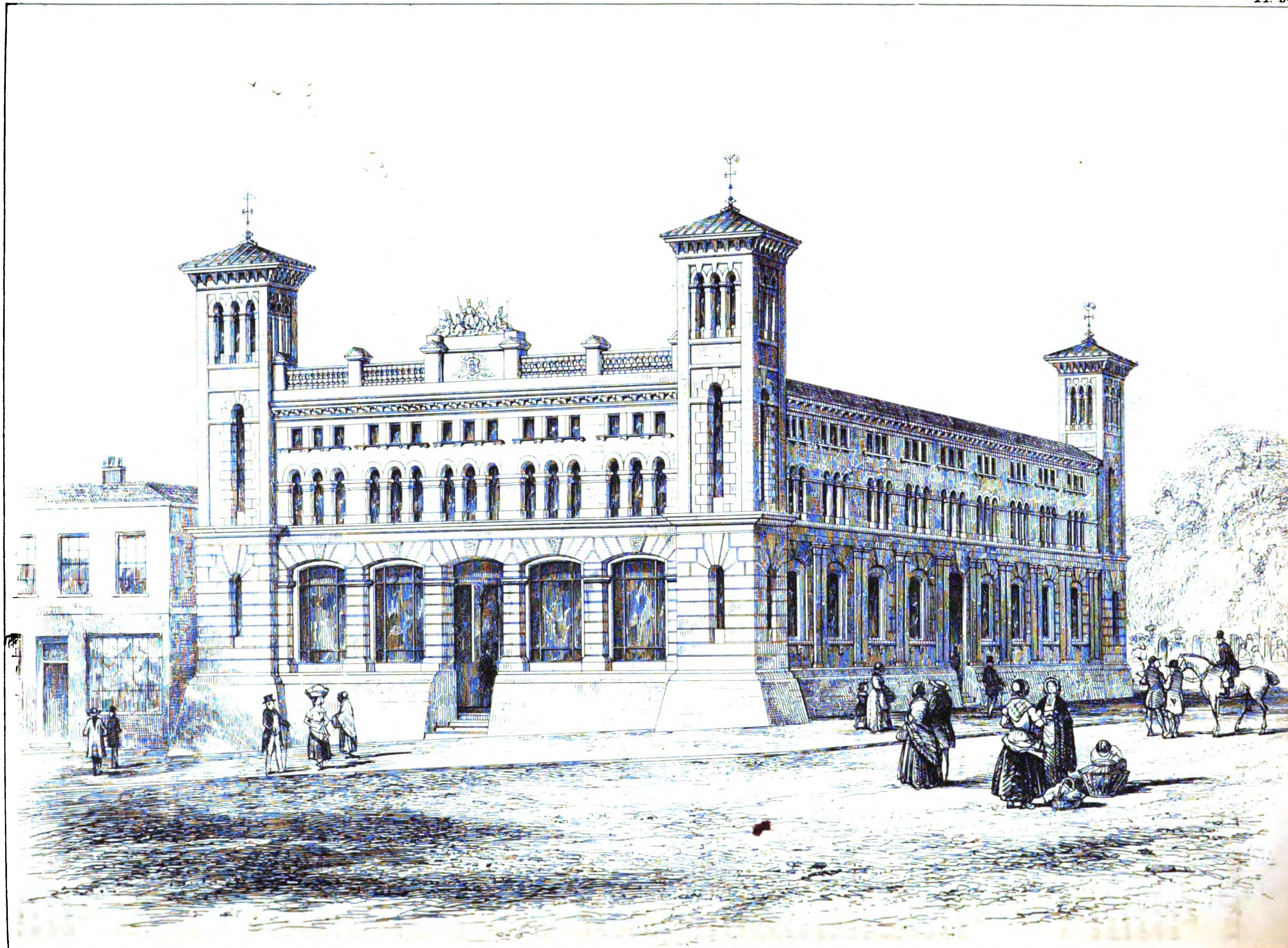
## PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

870. W. Ridgway, Hanley, Stafford—Improvements in the construction of ovens and kilns.—April 15
1086. F. East, Warminster, Wilts—Taking photographic views and portraits in the open air by means of vertible machinery attached to a cubical box, by which the changes are seen, and the light and the time of exposure regulated

Pl. 24.




NEW MARKET BUILDINGS, NORWICH

## NEW FISH AND POULTRY MARKETS, NORWICH.

(*With an Engraving, Plate* XXIV.)

The general plan is rectangular. The external buildings will be occupied by shops and residences for parties connected with the markets, while the interior area will be arranged similarly to the markets at Birkenhead; the whole being roofed in by a semicircular iron and glazed roof. A gallery will probably be formed round the interior. White brick, with Caen or Bath stone dressings, will be used in the erection.

A description in detail of these Markets will be given in our next number.

## THE CRYSTAL PALACE, SYDENHAM.

### ARCHITECTURE OF THE SEVERAL COURTS.

Much as has been said and written in reference to the marvellous building just reared at Sydenham, there are few persons but will confess, on its actual survey, that, even in its present state, the half has not been told. The prototype to a great extent, and no small portion of the materials, it is true, have previously existed in Hyde Park; but the general proportions, features, and internal arrangements, have been so vastly modified that the eye at once approvingly detects the difference. The experiment of the one case has resulted in a near approach to perfection in the other. In place of the rectangular forms so monotonously repeated in the former work, the outline is here most agreeably varied by the addition of two transepts, which picturesquely break the sky line; and, with their accessories, greatly help the perspective lines of the building, as well as the play of light and shade. Let us add, too, that in these, as well as the main roof, the *arch* form has been adopted, profiting by the only redeeming feature (in point of design) which the Great Exhibition structure presented; one, by-the-bye, not included in the original scheme, but suggested by an architect during the progress of erection.

It is a cause for national pride, to be able to point to a great fact like the Crystal Palace as the result of private enterprise appealed to in the interests of civilisation, and to reflect that the project has won the favour of royalty, the sympathy of general opinion, and hearty co-operation among all classes of distinguished men. And as the chairman of directors gracefully added on the inaugurative occasion, "the liberality of foreign governments opened every museum, and afforded facilities never before known, for acquiring a complete series of the finest works of ancient and modern art. The educational object embraces a complete historical illustration of the arts of sculpture and architecture, from the earliest works of Egypt and Assyria, down to modern times, comprising casts of every celebrated statue in the world, and restorations of some of its most remarkable monuments." It is this latter department in which we, as architects, are most interested, and to this will our further remarks be directed as we journey through the several courts, to examine a few of these *re*-creations, and also the modern creations in which they are enshrined.

Fain would we linger awhile on the threshold, to gaze over the parterres at our feet, so beautifully diversified by wood and water,—fain would we creep down to the lakes to try and comprehend those fearful-looking monsters that find place on their margins;—our fingers itch to record some of the curious statistics of the building itself; its vast dimensions, all based on the multiple of the datum 8,—its ingenious construction,—its brilliant colouring,—and the admirable adaptation of the whole to its purposes;—but we must forbear, and enter at once upon our task.

The Architectural and Industrial Courts are ranged on each side of the nave, and occupy its whole length, except where interrupted by the transepts: the space along the centre of the building and great transept being devoted to a promenade, which is terminated at each of the extreme transepts by a large fountain. For the sake of convenience our route shall be in the order in which the courts are placed in the building, beginning on the west side of the nave, at the south end, where we find

*The Pompeian Court.*—This is a complete reproduction of a Pompeian house, carefully—nay, exquisitely—detailed from a variety of authorities. The prevalent arrangement of these plans is a very curious one. From the entrance doorway there is a narrow *prothyrum*, or passage (on each side of which is a room devoted to the doorkeeper and slaves), by which we are conducted into the large area, or *atrium*, the part of the building common to all visitors. The central portion of this is open to the sky, and in the pavement is a basin (*impluvium*), of a size corresponding with the aperture, to receive the rain which falls from above. To conduct this, the roof converges from each wall of the area, and is carried by elegant brackets. Round the court are arranged the *cubicula*, or bed chambers (little, dark apartments), and the *alæ*, or wings, where business was transacted. Proceeding onwards, we come to the more private part of the house, in the centre of which is the *tablinum*, answering to our modern drawing-room, and on each side is a passage, the whole communicating with a spacious *peristyle*, and apartments belonging exclusively to the master of the house or his special guests. The exterior of this house is very simple in design, and gives little notion of the gorgeous fancy displayed internally. Here the utmost delicacy of tone in the decorations is preserved, the arabesques being painted almost uniformly on a dark ground on the lower part of the walls, above which the usual ground is, like the atrium, quite light, or even white. The columns of the peristyle must not be overlooked. The order is a kind of Ionic, the lower part of the shaft plain, and coloured deep red, the remainder fluted, and white; the whole standing on a shallow plinth, coloured green. Mr. Digby Wyatt and Mr. Falkener's excellent drawings in the Royal Academy illustrate our subject; and to the investigations of these gentlemen, as well as Messrs. Cockerell, Gell, Mazois, Donaldson, Hayes, and Zahn, we are indebted for all the practical conclusions displayed in this interesting building. Retracing our steps into the nave, we next enter

*The Sheffield Court*, exchanging the marble and tesseræ for iron and glass. This court, like many others in the building, is as yet quite unfinished, and, consequently, it is only possible to form an approximate idea of the intended effect; and this must be our apology in such cases, if the design be misunderstood, or if future experiments shall have suggested alterations. The architect of this court (Mr. G. H. Stokes), exhibits an interior view of it in the Royal Academy. Externally the design is effective, without adhering to any particular rule. It occupies the full height, up to the constructive girders of the gallery, of the building, and is divided into two ranges, the lower being large square compartments, entirely filled in with plate looking-glass; and the upper subdivided by a series of open arches of Moorish character, resting on slender iron columns. This story is profusely enriched by gilding, relieved by blue, red, and chocolate. The detail of these ornaments has been well studied. Between the two stories is a long horizontal strip or series of panels, painted a deep blue, which connects the parts and tells very well in the general composition. A word of commendation is due, too, to the design of the little open metal brackets in the angles of the doorways. We have said that this elevation reaches up to the girders, which are (as in the old building) deep and open, strengthened by diagonals between the flanges. This construction is now being masked, above the arcade just mentioned, by glass panels corresponding with those at the bottom,—but, as we submit, to the detriment of the general appearance. It looks flat and heavy, compared with the *open* ironwork, which might have been slightly decorated, so as to be in keeping with the light ironwork just below. Adjoining this court is

*The Birmingham Court*, designed by Mr. Tite. There is no novelty in the architecture, the detail of which is decidedly poor, especially inside. The nave façade consists chiefly of a cast-iron screen, in the spirit of those so much in vogue during the 17th century: this is both well conceived and executed. In the centre is the entrance to the court, between pilasters of enamelled slate (!) having heavy bronze Corinthian capitals, and shallow, liny bases, which rest on an ornamental cast-iron dado filled in with slate panels. This slate is a perfect deception: how far such deceptions are allowable, we stop not here to consider. The framework of the interior is quite tame, nor do the decorations by Mr. Sang please us so much as many we have seen from his hand. The upper part of the wall surface above the—cases of goods, we presume, for the work is incomplete—is divided into panels of a light ground, on which are paintings, in encaustic, of alternately vases of flowers and picture groups. The architrave above is plain, and, with the cornice, far too shallow. The frieze is filled in with scroll ornamentation on a very dark ground, giving it a coarse look. We are sorry our great manufacturing town should be so unworthily represented.

*The Stationery Court* presents at least a *contrast* to the one we have just left, but outside is not very prepossessing. Instead of the open screen of the Birmingham Court, there is one flat surface, dull in colour, and disguising the material, which turns out to be wood. In the stately entrances, however, though architectural rules are little attended to, a species of Cinquecento ornamentation is used with good effect. The tone of the colour is rich and agreeable, while narrow crimson diaper-panels introduced between the pilasters add richness to the composition, as does also the coloured glass of the windows above. The inside decoration is excellent, and worthy of its designer, Mr. Crace. There is a kind of lean-to (that is to say, lean-*from*) roof, in the way we have described over the Pompeian atrium, but not so well managed. Its covering appears to have no thickness, while the supporting brackets are needlessly heavy.

We now cross over the main transept, continuing on the same side of the nave, to the Architectural Restorations, and Fine Art collections, which form an invaluable series. On entering the first of these—

*The Egyptian Court*, an indescribable feeling takes possession of the beholder. We approach it from the nave by an avenue of lions (cast from the immense granite ones in the British Museum), and see before us the outer walls and columns of a temple, against which are eight gigantic statues of Rameses the Great. Turning to the left is a colonnade of early date and simple character; whence we pass into a dark tomb, also with columns, the date supposed to be about 1660 B.C. The original is cut in the *solid* chain of rocks, bordering on the Nile. Following on, we come to the other side of the colonnade before noted, encountering a forest of massive shafts, so closely planted that one can scarce thread between them, and covered with mysterious hieroglyphics, papyri, palm and lotus leaves, birds, and human figures, blended, banded, and entwined in the most odd-looking combinations. But we look through this outward medium to its, to us, hidden purpose, when hieroglyphics were the only written language, and these on the most conventional system, when historical events were handed down by bas-reliefs and sculptured representations, and the whole scheme of art, awful as it was, yielded to the austerities of a stern hierarchical religion. Yet, says Mr. Bonomi in his instructively-interpreting hand-book to this court, "the vast scale of the monuments of Egypt, compared with the space at our command, absolutely prevented any attempt at the reproduction of a single monument, or even a portion of one, of the *real* size. The monuments forming the 'Egyptian Court' must therefore be regarded *as models on a considerably reduced scale*."

Well may we retire in wonder, musing with the poet—

"———— How strange the story
Of Thebes' streets three thousand years ago;
When the Memnonium was in all its glory,
And Time had not begun to overthrow
Those ancient piles, and monuments stupendous,
Of which the very ruins are tremendous!"

*The Greek Court.*—From Egypt to Greece the transition is easy and natural. The fundamental principles of the one may be readily traced in the other,—but improved, added to, and perfected. The Greek Courts are placed, according to the chronological position of Greece in history, between those of Egypt and Rome; and the mode of junction, so abrupt and uncompromising, might give occasion for remark were we disposed to carp at trifles. Suffice it to say, that while to each department has been allotted a certain space, that space has not been found too great, and so if one group rather ungraciously elbows its neighbour, it is a fault of necessity and not of choice. The arrangement of the Greek area is very simple. It is screened off from the nave by a plain wall, pierced by three openings conducting to the interior. These openings are flush in the thickness of the wall, and consist in each case of distyle columns *in antis*. The order throughout is Doric, of the proportions in the temple of Jupiter at Nemea, which is less massive than some other examples. Instead of the triglyphs and metopes so usual in this style, the frieze of the façade is decorated with wreaths, alternating with the names of the ancient Greek cities renowned for their connection with the fine arts. There is an appropriate inscription on the architrave over each entrance.

The central entrance opens into the principal court. This is square, and being flanked by porticoes, resembles the ancient *agora* ('αγορα), or place of public assembly, answering to the Roman forum or market place. Here the same architectural features are preserved as in the front, also the frieze (of a rich blue colour) is enriched by wreaths, &c. in the like manner. There is an extraordinary degree of chaste purity in every detail and ornament; it can scarcely be surpassed. This court and the side porticoes communicate with a large gallery, principally for bas-reliefs, which fills up the remainder of the allotted space. Down the centre of this is a series of square antæ, giving the visitor another specimen of Greek architecture. The coffered ceilings, too, will not be unobserved. With a well-earned commendation of the very beautiful model of the west front of the Parthenon, nearly one-fourth the size of the actual structure, in which the minute architectural refinements discovered, chiefly by Mr. Penrose, have been accurately reproduced under his direction, our architectural notice must close. We cannot, however, but cast an admiring glance on the surpassingly lovely collection of sculpture around, in which nature, a faithful adherence to nature alone, reigns supreme. It is stated that this collection "is to be regarded as one in comparative infancy;" yet, however inexhausted may be the sources, or tempting the subjects, we would suggest that the additions be not so numerous as to disturb the sympathetic repose which now pervades this charming spot; where the gazer may feast in rapture on the choicest monuments of art, examine their individual beauties, and find new delights at every turn. Regaining our place in the nave, we discover

*The Roman Court* immediately contiguous, presenting, as a front, a portion of lower story of the Coliseum at Rome, about two-thirds the size of the original. In this elevation we find the great distinguishing mark of Roman architecture, the semicircular arch. This feature, as a decoration to buildings, has until very lately been considered peculiar to the Romans, nevertheless it was long known to the Egyptians, and consequently to the Greeks, but not used by them for any external purposes. This portion of the Coliseum is of the Tuscan order, whose columns are therefore here introduced. There is an appearance of heaviness in this screen, not a little owing to the plainness of its parts, and the unrelieved dulness of the material (an imitation of dark marble). The internal apartments are enriched with polychromy; and rare marbles, porphyry, and malachite, are also copied. The ceilings have been painted and decorated in accordance with remaining examples at Rome, such as Raffaelle, Giulio Romano, and Giovanni da Udine delighted to pourtray. Though the architectural restoration of this court is correct, and so far interesting, neither the type selected nor the raw contrast in the colouring is what we should ourselves have preferred. Among the numerous Roman casts, we discover, oddly enough (320), the Athenian Monument of Lysicrates!

*The Alhambra Court*, which comes next to view, presents an entirely new phase of art, betokening a high degree of civilisation, yet flowing in to us a comparatively unknown channel. A verbal description of this gorgeous work could convey but a notion of the reality; so peculiar is its design, its detail, and its every ornament. Mr. Owen Jones has a world-wide fame in connection with his illustrations of Spanish art, and with his curious explorations of the Alhambra, on which the adaptations before us are in great measure founded. The part here produced is the celebrated Court of Lions, the Tribunal of Justice, and the Hall of the Abencerrages. This Saracenic or Moorish architecture, doubtless sprang from the Byzantine, the common parent of all subsequent styles, and the legitimate successor to the Roman. The Alhambra may be characterised as "externally a solid structure of plain, simple masonry; while the inside was literally covered, from end to end, with rich arabesque work in coloured stucco, and adorned with mosaic pavements, marble fountains, and sweet-smelling flowers." Statues alone were excluded by the Mahometan law, based on religous scruples. The surface decorations here restored, all in flat relief, are truly wonderful, both as regards the intricacy of the design and its ever-varying contours. They afford of themselves an endless opportunity for study, alike of outline and combined colouring. In the small cast room will be found many more of these ingenious devices. Our pen would fail in the attempt to describe what must be *seen* to be really understood, and we therefore relinquish the attempt. Mr. Jones's hand-book is an invaluable companion to the visitor, and prefaced by a valuable essay on general art.

Emerging from the Alhambra Court, the scene is totally changed; and what a change! from ultra-delicacy to comparative barbarism,—from fairy land to the abode of giants; for know, O! reader, that we stand face to face with the two grim Egyptian

Colossi. These huge figures, even in their sitting posture, rise to a height of nearly 70 feet, and are just snugly throned under the arched roof of the transept. Close to these is the entrance to the

*Assyrian Court*, constructed by Mr. Fergusson, with the aid of Mr. Layard, out of data furnished by the exhumations at Nineveh. These gentlemen, it is well known, have applied themselves unweariedly to the task of illustrating a system of art of which no specimen has hitherto been produced in Europe, and which, indeed, until the last few years, lay unknown even in the country where its remains have been unexpectedly brought to light. As now laid bare to us, Assyrian architecture displays, in its main characteristics, enormously thick mud-brick walls, covered with painted bas-reliefs; and roofs supported internally by light yet elegant wooden columns, ornamented with volutes and the graceful honeysuckle ornament which was afterwards introduced through Ionia into Greece. We notice, too, in this reproduction a highly-enriched semicircular arch (from Khorsabad); dwarf columns, with strange, double-bull capitals; those curious emblems, the winged bulls, with their *three* front legs; and hosts of other sculptures and inscriptions in which the arrow-headed character is everywhere predominant. As this architecture, however, like the Egyptian, is to us of but historic interest, we shall not detain the reader by dry enumerations of detail, but lead him over the nave to the remaining courts, beginning with

*The Byzantine*.—The treatment of this court, and that of the Mediæval, Renaissance, and Italian, which follow in succession, differs considerably from those which we have just left. In the Egyptian, Greek, and other courts already described, the forms or characteristics of some one distinctive structure have, to a greater or less extent, been given; but those into which we are about to penetrate are not architectural restorations, but rather so many collections of ornamental details, exhibiting the chief transitions of art between the 6th and 16th centuries. Our reference to these specimens will be confined to glancing at a few of the most valuable or interesting of each class.

The arcade which screens the Byzantine Court from the nave, is taken from the cloisters of St. Mary in Capitolo, an ancient church at Cologne, supposed to date about the eighth century. In this may be traced most of the elements of the style in question; its bold, deeply-recessed arches, often, as in this case, subdivided; its stunted columns with their peculiar caps; its massive pilasters and flatly-moulded cornices, all clothed in a goodly array of colours, mosaics, and variegated marbles. The capitals in the present instance deserve particular attention from their beautifully-composed detail.

The central arcade is a compartment of the cloisters of St. John Lateran, at Rome (13th century), a fine example of the later Romanesque style. The detail of the twisted columns (whatever may be said as to the form itself) is exquisite, being richly executed in real porphyry, serpentine, and glass mosaic, to show correctly the brilliant effect of the ancient "Opus Grecanicum." Mr. Digby Wyatt's beautiful delineations in his book on mosaic decoration will occur to mind. Among the objects which court our gaze against the walls is the magnificent doorway from Mayence Cathedral, and others from Shobden and Kilpeck churches in our own country. In both the latter, painting has been restored, and every part of the surface covered,—it is to be presumed on sufficient authority. We observe the same in most of the other restorations, both internal and external; but, if we must own to the fact as an ancient practice, it is one to which we confess ourselves as yet not altogether reconciled. We prefer the natural colour of the material in what are called the "Elgin marbles" of the British Museum, to Mr. Owen Jones's restoration of their painting on the casts in the Greek Court. The imitation of flesh tints is peculiarly distasteful in these, as well as on the figures in the Byzantine doorways. May we quote a remark by Dr. Waagen, the distinguished German critic, on the subject? He is speaking of part of the pedimental sculpture of the Parthenon, compared with its plaster cast, and he observes: "I never perhaps found so great a difference between a plaster cast and the actual sculpture as in these 'Elgin marbles.' The Pentelic marble, of which they are formed, has a warm, yellowish tone, and a very fine, and at the same time a clear grain, which has imparted to these sculptures a peculiar solidity and animation. The block, for instance, of which the famous horse's head consists, has absolutely a bony appearance; it gives the impression of being the petrified original horse that issued from the hand of the god." How a coating of colour would have destroyed all this sharpness, and dispersed the illusion! The *extent* to which painted decoration was anciently carried is yet undecided.

Before quitting the Byzantines, let us draw attention, among other things, to the "Prior's Doorway" at Ely; the fountain from Heisterbach, on the Rhine; the inlaid Florentine pavements; and the interesting early monuments on the floor. In

*The Mediæval Courts*, architecture and sculpture have taken a progressive step, and a collection of objects, renowned for their beauty, their variety, and their availableness for study, has been secured, which time would fail us to chronicle. There is one circumstance which this superabundance of materials seems to have forced upon its arrangers which is much to be regretted. We mean the composition (nosegay fashion) of certain groups, made up from different sources. Thus, in the large buttresses within the English court, the weatherings are gabled and niched after a recognised type; but, striding on these gables, are clustered corbels from *Wells*, which, in their turn, form rather clumsy pedestals for statues from another place; and these, again, are surmounted by *modern* canopies (as we presume). A Lincoln gabled doorway is finished with a Cambridgeshire church cross; and little figures have crept, cuckoo-like, into nests which it was never designed they should fill. Thus anachronisms are more or less committed, and distinctive localisms cancelled; and while the experienced eye detects the innovation and is pained, those who come to be instructed go away under a false impression. We have already touched on the subject of polychromatic decoration, which is here freely administered.

Adjoining the "English Mediæval court," are two smaller ones, devoted respectively to "German," and to "French and Italian" sculpture. Next in order comes

*The Renaissance Court*, which presents towards the nave an open arcade of nine bays, uncomfortably crowded with *petite* ornaments. It is modelled from the Hotel Bourgtheroulde example at Rouen (dating about 1520, or later); the open arches are of a nearly elliptic form, called *Burgundian*, the whole showing a lavish amount of richness, and a struggling with the influence of late Gothic art. What may be called by admirers of the style, the light prettiness of this screen, with its delicate gilding, is greatly marred by the heavy sculptural frieze from Pistoia (Tuscany), introduced above, which completely overwhelms it.

The harmony of colour in the interior of this court is pleasing, since a gradation of tints has been preserved. The wall surface is a quiet diaper pattern, succeeded by more positive colour, chiefly blue, toned down by occasional panels of other hues; the whole crowned by a well-moulded cornice, and an unbroken attic story. Arabesques and medallions on a white ground are introduced by way of enrichment. Within the inclosure is a well-selected series of castings, including the glorious, the matchless gates, by Ghiberti, to the Baptistery at Florence. The rest we must pass by unnoticed; but perhaps it may be the place here to refer to Mr. Digby Wyatt's screen at the south end of the nave, prepared to exhibit casts of the regal statues executed by Mr. John Thomas at the New Houses of Parliament. This screen is not, to our mind, altogether satisfactory. The square piers seem too massive for the slender arcading between, and they interfere with the continuity and due importance of the figures; the cornice and its surmounting sculpture are poor, and the narrow central feature in the design excessively paltry and frittered. We say this in deference to its talented designer, Mr. M. D. Wyatt, who, in the "Renaissance" hand-book (p. 14), comes out as champion of the style against those who have termed it "pestilent," and who may be better acquainted with its proper mode of treatment than we can profess to be.

*The Elizabethan Vestibule* is small, and its architecture little more than three repetitions of three arches from the exterior of Holland House (coloured, of course). The four doorways within are also all alike. Above the arcade cornice is a large fleur-de-lis cresting, which in the original, if we mistake not, forms the termination. Here, however, its disproportion is more evident, from its being filled in solid between the ornament, to support the last compartments of the Pistoia frieze, which we mentioned as overtopping the Renaissance façade.

This court contains several interesting monuments,—the Scotch Queen Mary, and the English Elizabeth, with the Stratford-on-Avon Shakspeare looking down upon her,—and the elegant tomb of the Countess of Richmond, by Torregiano, the Florentine artist who designed that of Henry VII., which also finds a place near.

*The Italian Court*, in its architecture, is borrowed from the Farnese Palace at Rome, which was the joint work of Sangallo and Michael Angelo. Here, again, colour is introduced of an agreeable tone. The internal area is ingeniously broken on plan, so as to make a central open quadrangle, and two side passages which are treated as interiors. The style of decoration is familiar to all who have met with Gruner's splendid work on the art as practised in Italy. Behind these areas is a long gallery, the flat ceiling of which (imitated from the library at Venice) is unusually tasteful. Copies from the productions of Raffaelle, M. Angelo, Bernini, Sansovino, and others, form an interesting assemblage for study.

*The Italian Vestibule*, as it is termed, is, like the "Elizabethan," but a small space, yet containing several gems of art. Like, too, the court just mentioned, its architecture consists of repetitions of three arches of an arcade, with their appropriate entablature. The model chosen is the Casa Taverna, at Milan, and a beautiful specimen it is, though very simple. The archivolt and spandrils are particularly worthy of attention, from the effectiveness of the overlaid ornament. Triglyphs are indicated on the frieze, but *painted* instead of being in relief.

Before we pass over the central transept to examine the remaining courts, we cast our eye on the sculptured memorials of great men of every age scattered about and around. Among them are not a few who won a distinguished name as architects; to wit, Brunelleschi, Michael Angelo, Palladio, Inigo Jones, and others.

Resuming our track, we approach, close to the large transept, the French and Italian sculpture; and next to this the French or Foreign court, designed by Sir Joseph Paxton. The style he has selected is Late Gothic, almost Flamboyant, if we take some of the features as samples. It is constructed of wood, emblazoned with colour, and with panels of silvered plate-glass. Internally, the detail is tame, and somewhat wiry. A series of arches, forming recesses, runs round each of the sides, inclosed in square compartments. The spandrils are enriched with perforated tracery; from the moulded cornice springs a small cove, by way of partial ceiling, as in some of the other courts, and there are decorations of shields, emblazoned with the arms of various nations, and legendary scrolls, setting forth the names of the principal seats of manufacture. Next comes

*The Mixed Fabrics' Court.*—This presents some novelty in its plan, being divided into two parts, one covered by a ceiling, to receive the more delicate fabrics likely to suffer from exposure, &c.; and the other uncovered, and destined for raw produce, and that less susceptible of injury. The ceiling of the covered portion is elaborately painted. There is considerable invention in the general design, which may be called of Cinquecento character; not that we like the broken pediments and vulgar panels which this style favours, and which may here be seen; still the architect (Professor Semper) has produced an agreeable variety.

*The Printed Fabrics' Court* is a very good one. It shows towards the nave a centre arch, flanked by projecting columns, with the entablature broken round them, and surmounted by vases. Beside these are niches for statues, above which are panel paintings, illustrating on one screen printing and weaving, and on the opposite spinning and dyeing. The columns are of dove-coloured scagliola, having very chaste white Corinthian capitals, touched out in gold; in the spandrel of the entrance arch is introduced a monogram of the architects, Messrs. Banks and Barry. The wings are composed of three Byzantine arches on each side, springing from slender doubled iron columns, and over the whole a well-proportioned entablature is continued, with a modillion cornice. The walls are adorned with medallions of eminent men in this branch of manufacture, and the frieze with bas-reliefs representing the raw material, and its several processes.

*The Musical Instrument Court* is the last we have to visit It is one in which inventive fancy has been altogether unrestricted. The four angles are strengthened by engaged columns, in which organ-pipes supply the place of flutes,—a misapplication by no means to be tolerated. Close to these are chamfered corners, with veritable Gothic stoppings. There are symbols of every possible kind in connection with the practice of the "divine art," and internally medallions of the most celebrated English and foreign composers, and a frieze prettily enriched with figures of boys playing on various instruments. The opening stanza to Collins's 'Ode to the Passions' forms an appropriate external inscription.

We are now arrived again at our starting-point, having completed the circuit of the building. If our notes have appeared occasionally desultory, let it be remembered how much it has been necessary to condense to bring them within readable limits; and, now that our readers have the opportunity, as they have doubtless the inclination, let them repair to Sydenham, and, at their leisure, fill up the outline, thus slightly sketched, with pleasure and profit to themselves.

## THE CRYSTAL PALACE AND ITS INFLUENCE ON THE ARTS.

We look with the deeper interest on the Sydenham Palace, because we long since anticipated the permanent influence of the Great Exhibition building on architecture. We have pointed out that the successful application, on a gigantic scale, of a new combination in construction would lead to a new class of edifices, and ultimately to a new style. The buildings at Dublin, New York, and Paris, are as yet only partial exemplifications, nor is the Sydenham structure to our minds anything more than a rudimentary step in the chain of progress. It is vast, undoubtedly, in its proportions—it is as yet unexampled; but, we are inclined to believe, far behind what is yet to be achieved in this department. The building is an extension and expansion of that in Hyde Park, but it can scarcely in reference to its architectural properties be regarded as a new example; it belongs to the first type, rather than to another original type; neither has it developed distinctive properties of style, such as we believe the material employed is capable of displaying. We do not say this to disparage the Sydenham Palace, for it is one of the most remarkable monuments the world has yet seen,—but we say it hypothetically, in reference to the artistic resources of which the subject is capable.

So far from speaking in the former sense, we look upon the Crystal Palace as an example essential for the architect to study, if he would properly appreciate the present position of his art, or its future direction. We have there displayed a vastness of proportion and capacity such as is seldom seen in modern structures, and most certainly unexampled for its rapidity and entirety of execution. The Louvre, or the New Houses of Parliament, wanting the latter qualities, cannot be brought into comparison. Then, too, the material presents peculiar artistic properties—its transparency, its reflective surface, are distinctive characteristics. If in other structures solidity is urged as a merit, here the very lightness is an advantage, producing its own proper effect, and affording a special resource to the designer. The application of glass and iron admits of adaptation for institutions particularly suitable to our climate and habits. Instead of the contemplative recreations of the porch, or the quiet of the siesta, or the warmth of the winter stove, our habits are essentially active and peripatetic: we like to move about at all seasons—to walk, to talk, to see, to be seen. Public meetings, religious anniversaries, races, parks, zoological gardens, flower shows, public gardens, and fairs, are eagerly sought for as occasions for meeting; but the winter presents few opportunities for such réunions. The theatre, the concert room, the ball room, and the casino do not afford such occasions for large assemblages; and the only winter garden attempted is on too small a scale. Marble halls, or prolonged galleries, well warmed, afford no adequate winter promenade.

Had the winter garden of the Royal Botanic Gardens in the Regent's Park been carried out on the contemplated scale, it would have had an acre of walks and plantations, and would have given a very good example of a place of winter resort. In its restricted dimensions, it is of too narrow application, although it sufficiently illustrates what may be done. The glass structures, with the use of warm-water heating, will give professional men a scope for what we may term winter architecture. There is no more inconvenience in going to Sydenham from the station than in going to the opera, and as the building admits effectively of artificial illumination, it may become a place of resort in the winter both at day and night, and may be applied to purposes as yet little contemplated. There we may have winter and spring flower-shows, when particular classes of flowers are in their prime; there may be held cattle and poultry shows, with more convenience and on a far larger scale than has yet been effected. Promenade concerts may be held under cover, and rival the fashionable assemblages of the summer. Thus, resources may become available to the managers which will contribute regular and permanent branches of revenue.

What may be done at Sydenham may be done by the architect in other places, and we may gain exhibition structures for other towns and districts. At Sydenham it is little likely that any extensive modification of the building will take place; but it is in the competition for other structures, and in the rivalry among architects, that the occasion will be found for producing new effects, and developing the properties of the style. Liverpool, Manchester, or Birmingham, may invite competitors to endow it with an industrial palace, and a great rival to Sydenham may arise. Other applications for special purposes will be made in the metropolis—indeed Sir Charles Fox has already proposed such. Perhaps the situation first suggested on the esplanade of Battersea Park may yet be occupied with a crystal edifice.

The situation of Sydenham is a happy one, and the gigantic proportions of the edifice are conspicuously seen, situated as it is on the southern range, and it would be difficult to find a better position in London of the like kind. A site on the northern range would have a southern aspect, but there no such space remains available. There are likewise many of our large towns in which such a situation cannot be obtained. The proposition made long since in this *Journal* for a crystal palace on the terrace of Battersea-park, pointed out the artistic effect produceable from the elevation of such a building on the river side casting its shadows and its reflected lights on the gleaming waters. A structure of this class, with a southern aspect on a river frontage, would have a most picturesque effect. There are likewise situations on level ground, amidst trees or park-like scenery, where glass edifices may be artistically placed, so that the capability of this material for various sites constitutes one of its advantages. The adaptation of the structure to such diversified positions will lead to modifications in design, which will effectually lead to some new or definite style. The old styles cannot be so closely followed in this material as to admit of strict application, and therefore the change of material must, we think, necessarily lead to extensive modifications of style, if not indeed to the absolute extent of a new style. The very adaptation, as in this example for instance, of old forms, leads to such alterations and changes, to such departures from precedent, and such new creations, that it is already equivalent in architectural value to the origination of a style. A mediæval cathedral is scarcely more distinctive than a crystal palace; they are each works of a special class, having differences so great that we are fully justified in placing them in comparison with those which result from characteristics of style.

The material employed, arranged to a greater or less extent in sheets, produces a uniformity and entirety of arrangement, such as do not necessarily attach to stone. It admits perhaps of less variation of form, and is less plastic, although the metal or timber framings and supports allow of every diversity and luxuriance of shape. The glass surface gives a mass and entirety of effect which must very much influence any style adopted, because although marble or stone may produce a surface equally uniform, this is not an essential property, for they may be as richly carved as Henry VII. Chapel, and be altogether without repose. It is possible, however, that at a future time, by the use of coloured glass, polychromatic effects, both exterior and interior, may be obtained correlative to those of ordinary polychromatic decorations, though very different in their form, for these are opaque, the others transparent. The painted windows of churches can give only a partial idea of what would be the resultant effect of an extensive crystal palace largely varied with coloured plates. It is evident the same richness of colouring and of transmitted light which is obtained in scattered cathedral windows, is available in suitable situations, but it will be further seen that masses of coloured light may be thrown in to a degree far beyond what has been effected by the most gorgeous east, west, or transept window. The crystal palace, as we now know it, bears the same proportion to the mature decorated structure, that a whitewashed modern columniated building does to the Parthenon in all its glory and vivacity of colour.

There is a scope for the management of light and colour, which Titian, Rubens, and Rembrandt would envy. These, worked on an easel, in their great decorations, Michael Angelo, Raffaelle, Giulo Romano, or Rubens thought himself happy to have the share of a chapel or a hall; but the artist of a crystal palace may have a thousand feet in length of a transparent medium on which to exercise his genius. There, too, he will have living colours, brightened by the sun's beams, pouring columns of the richest colour through the interior. The scenic effect of coloured light is a most valuable resource to the designer of spectacle, who is obliged to avail himself of artificial illumination; but in the proposition referred to, the great luminary of nature will be brought in to aid the effect.

When examining the Great Exhibition, we took the opportunity of pointing out how little the properties of transparent colouring, of coloured lights, of moving lights and substances, and of glass, had been studied by the artist, though capable of producing the greatest effects. We believe they have been neglected partly because colour has been altogether and wrongly neglected by the architect till of late, and partly from another erroneous theory, that such applications were artifices for the decorator rather than for the artist. The controversy as to coloured statuary in the Crystal Palace has resulted rather in the temporary victory of the purists, but the Crystal Palace itself is laying the foundation for their certain defeat. By its successful realisation, all their theories of the sublime and beautiful are set at naught. Here is a monument of the most flimsy instead of the most solid materials; much of its picturesque effect on the eye is owing to the play of light on its surface, and one great feature in the completion of the design is the establishment of giant fountains, spouting columns of glittering water in front of the gleaming walls. The mason and the bricklayer, the chosen servants of those who aspire to endless durability, are set aside, and workmen either neglected by or almost unknown to the builder, are those who have reared the structure. In the evidence of mind, in design, in the realisation of beauty, fame has been sought, instead of in marble and in stone, in brick and cement. Nevertheless, the fleeting gleam of the many-coloured rays of an oriel window, is as truly an offspring of art, and one as lasting as any portion of the edifice. It shows the mind of the designer as well, and is truly appreciated by the spectator, for whom, and not for the critic or the archæologist, does the artist labour.

The subtle and delicate properties of form are truly worthy of occupying the mind of the artist, but there is no æsthetic reason why they should exclusively demand his allegiance. In later times, the architect and the sculptor have limited themselves to the speciality of form apart from other properties—and yet on no valid ground, not even on the ground of precedent. It cannot now be denied, that in all other ages than the last two or three centuries, architects and sculptors have dealt largely with colour as well as with form, and have not thereby felt themselves degraded. Painters vary in their appreciation and application of the properties of form, yet no one thinks the worse of Michael Angelo or Raffaelle because he painted as well as drew cartoons. There is not one argument, indeed, for the exclusion of colour from architecture and sculpture which does not equally apply to painting. There is an enjoyment derivable from the properties of colour apart from form, which, in its abstractedness, is as pure as that derivable from the properties of form. The restriction of the practice of art to the latter has nevertheless no better basis than a vague, mystical notion, which seizes the more readily on some minds in proportion to its want of consistency and definedness. If purity of form is enhanced by being enjoyed alone, and by being exhibited isolatedly, then an outline cartoon must be the height of pure art; and it may be submitted to the purists whether the play of light and shade, which, both in architecture and sculpture, contribute so highly to effect, do not, like colour, impair the pure enjoyment of abstracted form.

The more catholic the appreciation of the beauties of nature and of the resources of art, the higher aimed will be the exertions of the artist, and it is equally honourable to him to work with slight materials or with small material. How anomalous is that law which would restrict an artist to marble and stone, and those only of one colour, and who require that his structures shall be of the greatest proportions and of the most durable materials, and yet will assign the honours of immortality to the designer of an altar-piece—nay, even of a cabinet picture. After all, there are more painters known to the world than there are sculptors,—perhaps as many sculptors as there are architects whose names are in the mouths of the many. What is the object of ambition in architecture? To produce a monument, which shall take years, perhaps centuries, to heap together the material, and yet perhaps remain incomplete. Under these circumstances, few are so happy as Wren or Barry, and raise a great edifice from the ground. Most great monuments have had several architects; a succession of them, and the distinctive designer becomes lost. Who was the architect of St. Peter's? who of this building, who of that? The cognoscente must give an answer in set form, the public know it not. Hence, too, the ambition of the architect is early cramped; he may design palaces and cathedrals as he likes, but it is a rare lot if it be his to execute one. In fact, he has to limit his ambition, and esteem himself happy if he be intrusted with the execution of a small structure. The new style of construction, however, admits of large proportions and rapid execution; it gives a man the opportunity of showing his artistic power and of acquiring distinction, and it must thereby react on the future of art in a most favourable manner.

Many of the large structures we have had of late have been those which have had the least pretensions to art—warehouses, factories, and railway-stations, though their plainness or ugliness is not a necessary or inherent property. The crystal palace must however be of a decorative character, and avail itself of the resources of art, and it gives a favourable opportunity to the artist. Architecture has the advantage over all other arts that it can deal with vast proportions and almost illimitable form, and the greatest colossus of the sculptor or founder, and the greatest fresco of the painter, bear no comparison in size with the creations of the architect. Hence, the new field of display will necessarily promote a greater breadth of treatment, a quality more necessary to the architect than to any other artist. It is not indispensable to the painter, and the sculptor has scarcely scope for its display. By giving the architect better opportunities for the realisation of his ideas, we shall give him a stimulus to exertion and the means of practice, without which chamber studies will do little towards making an architect. One or two men in their day may now hope for adequate commissions, but hereafter the occasion for exertion will be more frequent, and genius will have a fairer field against favoritism.

The new Palace at Sydenham will likewise, it seems to us, further benefit the architect by giving him an educated public. We shall say nothing now about other branches of study, but we shall limit ourselves to architecture, though the Crystal Palace is the grandest educational institute the world has yet seen. There is no college which could have been opened, no free library brought together, there is no intellectual power in twenty libraries of five hundred thousand volumes each, which will do as much as this Crystal Palace. It is that very library which the public want,—one which the eye can embrace in the integrity of the subject, and with which even the British Museum can bear no comparison, though it brings together originals where the Crystal Palace relies upon models and casts. It is because the Crystal Palace does so, that it is a better public teacher. The British Museum, with its original types, is invaluable to the man of learning and the teacher, and, in intrinsic price, is far beyond Sydenham; but the latter possesses the essentials for popular instruction in art. Even if lecturers were attached to the British Museum, as they ought to be, it cannot compete with the Crystal Palace, with or without lecturers. Inasmuch as an infant school is better adapted for a babe than the University of Oxford, so is the adaptation of the Crystal Palace to the popular wants greater. Compare the Nineveh or the Egyptian collection in the two palaces, and it is evident that the public will learn more and more readily at Sydenham than in Bloomsbury. The necessities of a museum are against it. It must avoid restorations, it must avoid imitations, it must avoid theories possibly erroneous; but the public want a complete idea, even if erroneous, they cannot suspend their judgment, they cannot abstract thought; the subject must be laid before them in something like connection, even if the connection be made up by hypothesis. The British Museum, again, cultivates archæologists and professional men; the Crystal Palace teaches a public, and a public is what we have long wanted for architecture. If we had a public as decided in their views upon architecture as they are upon other subjects, the deputation of the Institute would not obscurely go to petition for the fragment of a corner in St. Paul's Churchyard—which it is doubtful if they will get—but it would boldly demand and obtain what was required.

All that the public can learn of architecture in London, or even in England, amounts to very little. They can neither see mediæval buildings in their integrity nor genuine imitations of Athens; it is as much as they can do to get a notion of the Italian styles. Everybody cannot travel or purchase expensive books, and therefore, so far as catholic appreciation of art in architecture is concerned, it has been hitherto limited, but now we have at Sydenham a great school of architectural study. We care not whether the architect can learn enough there about Pompeii or Thebes, but of this we are sure, that any man, woman, or child, can obtain a definite notion of various styles and modifications of art, such as will, without reference to accurate or minute information, produce a beneficial impression. Scholars may dispute whether the tablinum or impluvium be according to the best authorities, and whether the restoration should be in this form or in that; but the public have been hitherto contented with far less than they now have, while, as they acquire instruction, they will find in the careful selection of well-authenticated subjects at Sydenham the materials for a further study, which will often be specially applied by the artisan and designer in his own pursuits. The interest of the public in architecture will be increased, they will find there is much to admire, and they will be found ready to appreciate.

## WATER SUPPLY AND SEWERAGE OF SWANSEA.

By Robert Rawlinson, C.E.

[*Abstract of a Report to the Local Board of Health, Swansea.*]

In establishing works of water supply, it is of primary importance to obtain the best source. The water should be the purest to be found in the district. The area from which it is to be drawn should be large, and free from works the tendency of which would be to taint the supply. If there are springs, they should be collected at the respective sources, and be conducted by means of earthenware pipes into covered fountain reservoirs. That source is the best which not only enables an engineer to secure such conditions, but which will enable him to supply the quantity required, or likely to be required, at such an elevation as will give high pressure, without pumping, and volume without flood-water storing. Any moderate cost of additional distance in length of aqueduct main may safely be incurred to secure works which will yield such a supply.

The Clydach district is the only place within reach of Swansea where the advantages enumerated can be secured. The minimum volume of water in the river is several millions of gallons per day. The district, as is proved by the analysis of the water, is free from mineral impurities; the land, from its slope, mountain character, and isolation, is not likely to be more highly cultivated or more densely inhabited, and there is elevation sufficient to give any required level above the town, with high land the whole distance, round which a comparatively cheap earthenware pipe conduit may be laid to service reservoirs above the town. Another advantage, and the greatest, consists in the district abounding with springs of singular purity, most of which are at elevations to render their waters available. Fully one-half the water required by the town may be, as it were, created; that is, by collecting the springs, and by preventing evaporation and waste, water will be obtained which at present is lost on the mountain side, never reaching the river or the mills.

The existing works do not supply the higher parts of the district, neither can they, in my opinion, ever be made available for this purpose; they may however admit of some improvement. The area of land above the old and new reservoirs is too limited and the springs and streams too small, to yield a full supply of water for a large and rapidly-increasing town. The water is also comparatively hard; and, as stored in open reservoirs, must be impure. At the time of my visit there were numerous tadpoles; at all times there will be conferva and animalculæ. The reservoir is at an elevation too low, and the volume of water too small. Engine power would raise the water to a sufficient elevation, but I do not consider there is area or water at command, to warrant such an outlay; or, indeed, any costly permanent extension.

In order to render the waters of the Clydach available, it would be necessary that the springs should be collected at the respective source, and be conducted through earthenware pipes into a fountain reservoir, which must be covered. The line of aqueduct main will contour the land as far as possible. Valleys, or water-courses may be crossed by light aqueducts, continuing any given gradient; or cast-iron syphon pipes may be adopted. Small covered service reservoirs may be constructed at the most convenient points where a supply is required, for populations situate on the line of the main; and one or more service reservoirs will be required for the town, at such elevation as will command every house within the borough. From these service reservoirs the mains, sub-mains, and branches will proceed into the town, and conduct the water into each street and every house, preserving it pure and cool, as collected from the springs.

The distance from the Clydach to Swansea is about seven miles; that is, an aqueduct main winding round or contouring the high land will be about seven miles in length. An earthenware pipe may be laid complete, capable of conveying one and a half million gallons of water in 24 hours, at a cost not exceeding ten shillings per lineal yard. This would make the cost of such a main about six thousand pounds. The necessary works on the Clydach for collecting springs, &c., need not cost more than four thousand pounds, making in the whole, for collecting the water and conveying it to Swansea, 10,000*l.*

Service reservoirs, service mains, sub-mains, and branches, within the town, will not cost more than fifteen shillings per head, making, for a population of 30,000 a sum of 22,500*l.* Add for land compensation, engineering, incidental expenses, and other contingencies, 10,000*l.* and the estimate will be as under:—

| | |
|---|---|
| Works on the Clydach | £4,000 |
| Aqueduct Main to Swansea | 6,000 |
| Plant within the Town, Service Reservoirs, Pipes, &c. | 22,500 |
| Compensation, land, engineering, and incidental expenses and contingencies | 10,000 |
| Total | £42,500 |

Mr. Scott estimates that the cost of water works (for an increased population of 55,000) would be as under:—

| | |
|---|---|
| Works on the Western District | £91,000 |
| Works on the Cwmgelly District | £55,000 |

The works, as projected for the Clydach district, will serve for a population of one hundred thousand, and may, at any time, be increased to serve a population of half a million, without the loss of one pound of the money expended on the projected works.

With regard to the sewerage of Swansea it appears that, with the exception of that portion within tidal influence, there will not be any work to execute either difficult, peculiar, or costly. Brick outlet sewers will be required in the low and level parts of the town; but in the higher parts, and along streets of steeper gradients, earthenware pipes may be adopted with advantage and economy. The necessary works for a population of 30,000, were estimated by Mr. Rawlinson to cost 25,000*l.*

## DRAINAGE AND WATER SUPPLY OF FALMOUTH.

By Robert Rawlinson, C.E.

[*Abstract of a Report to the General Board of Health.*]

The town of Falmouth stands upon a dry formation (clay slate); there is scarcely a square yard of low or level land. The means of atmospheric ventilation are good; and yet fever is said to be ever, more or less, present, and cholera has prevailed to as great an extent as on sites low, flat, and excessively damp. The same remarks apply with equal force to Plymouth, Dover, Tynemouth, Newcastle-upon-Tyne, Gateshead, and Sunderland. Cholera is true to no condition but filth. It breaks out in a dirty swamp at the level of the sea, and it rages at elevations hundreds of feet above this level; if the conditions exist, namely, populations living amidst their own filth. A town may be at the sea margin, as Falmouth, Dover and Plymouth; or inland, and at an elevation of 500 feet, as Bilston and Wolverhampton, in all of which places there has been cholera.

The district, included by the town of Falmouth and the parishes of Budock and Falwick, contains 1555 houses and 10,079 inhabitants.

The surfaces of streets, yards, and courts may be very clean, as in Paris, but the atmosphere may be very foul from decomposing refuse in cesspool and sewer beneath the pavements; and even where sewers and drains of transmission are in use, and where surface cleansing is also attended to, but where rooms are overcrowded, there may be an excessive mortality. The atmosphere is as effectually poisoned by overcrowding as by refuse retained in any form above described. The end to be attained by sanitary works or regulations is to secure pure air.

The gross estimated rental of the town is 7530*l.* 4*s.*, and the rateable value thereof is 6275*l.* 3*s.* 4*d.* More than one quarter part of the poor-rate (rateable value) is assessed on the owners of tenements, under the Small Tenements Act.

The harbour of Falmouth is a splendid sheet of water, presenting an area of some ten square miles, protected by high lands, so as to be a safe haven for shipping. Average spring tides rise 18 feet, neap tides about 7 feet. Heavy gales occasionally bring the water in two or three feet above the ordinary level of the tide.

The town of Falmouth extends about 2000 yards north-west and south-east along the south-western shore of the harbour; it is built on the side of a hill, there being scarcely any portion level. Nearly the whole of the houses bounding the harbour stand upon walls, which are washed by the tides; the line of wall and the fronts to the harbour being most irregular in line. In breadth, the town is about half-a-mile; it has outgrown the municipal borough limits, and extends into the parishes of Falmouth and Budock.

The streets are steep, narrow, and crooked; but crookedness and narrowness are common to most of the old towns in Cornwall. The buildings rise, terrace over terrace, abruptly from the water to an elevation of more than 100 feet. The municipal borough has been much over-built, and is now extremely crowded. Sites for houses and yards have been excavated in the rock; and as there is no proper drainage, the refuse from the upper inhabitants flows down to the annoyance and serious injury of those below. Many houses have been erected so that a privy cannot be constructed; and, as there is no effective drainage, the parties cannot put up a water-closet. In some cases one privy serves for many houses, and those who have no privies use a tub, which is emptied at intervals. The corporation and guardians have effected many improvements since 1848, but finding the most active measures ineffective, they have now applied for the powers of the Public Health Act to enable them efficiently to sewer and drain the town.

There may be perfect drainage, at a moderate cost, and there is a public supply of water which only requires filtering. The average annual rain-fall is about 36 inches. The advantages of comparatively soft and pure water, combined with site and climate, are seldom found. All places on the chalk or oolites have the great drawback to health—hard water. A railway now in course of formation will place the town within ten hours of London.

The town stands on *killas* (the local name for clay slate), granite forms the surface inland, rising at Carn Menelis to 820 feet above the sea. The shores of Falmouth harbour, which are principally mica slate and clay slate, rise some 200 and 300 feet above the sea. Dykes, veins, and "lodes" traverse the unstratified and stratified rocks; alluvium,—sand, gravel, marl, and clay,—covering portions of the surface in the valleys. Granite and slate, thinly covered by vegetation, or exposed, forming the higher land.

The present drainage is confined nearly to surface drains, there being no proper sewers; these drains are mostly built of rubble with slate bottoms, and empty themselves into the sea. The length of highway or streets, within the corporate district, is 2022 yards, of which about 300 or 400 yards only are provided with even surface drains.

Mr. Rawlinson recommends that each street and road should have its appropriate sewer, and each court, house, and yard its proper drain. Open cesspools should be abolished, and water-closets or common soil-pans should be substituted for the privies now in use. Any accumulation of refuse in large, exposed, or covered middens should be prevented by a regular removal of all such refuse at short intervals. That the rates be expended in opening out courts and confined places, in widening narrow streets, in rounding protruding corners, or in erecting covered markets, and costly public buildings. That all fluid and semi-fluid refuse, liable to decomposition, be at once removed from the site; cesspools abolished; sewers and drains through which such refuse will flow should be substituted; streets paved, and all lanes, passages, yards and courts, flagged, or otherwise finished so as to admit of sweeping or washing; ashes, and other solid refuse being removed at short intervals.

The sources of the supply of water to the Falmouth district are certain springs and streams at Kegilliack and part of the College river. The reservoir is situated at an elevation of 178 feet above high-water mark of spring tides, and calculated to contain 179,200 cubic feet of water; from this reservoir a 9-inch main is carried to the market strand, a distance of two miles, from whence the water is disseminated throughout the town. The cost of the works amounted to upwards of 12,000*l*. The water, as at present supplied, is dull and turbid, requiring filtration, and at times is tainted by the rusting of the pipes, by reason of the want of a quick and constant draught. These evils the company will find it advantageous to remedy immediately. The gasworks and slaughter-houses are also nuisances demanding the powers of a local act to remove. A new cemetery has been formed at Hangman-hill, about a mile from the borough, which it is hoped will abolish the dangerous practice of intramural interment in Falmouth.

It is proposed to erect public baths and wash-houses in Falmouth, and to extend the boundary of the borough so as to include Budock, Pendennis Castle, Flushing, and Little Falmouth; a portion of the harbour is also included, but it is not intended to interfere with the jurisdiction of the port. This boundary, as proposed for the purposes of the Public Health Act, contains only a portion of the area of the proposed extension of the municipal borough.

## STONEWARE DRAIN-PIPES WITH WEDGEULAR JOINTS.

— Roverr, *Patentee*, October 31, 1853.

Fig. 1.

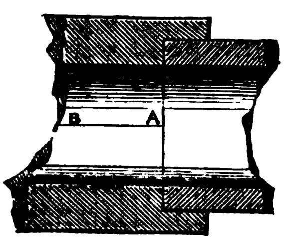
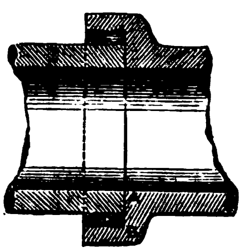



Fig. 2.



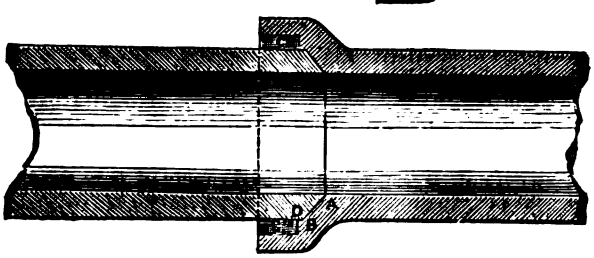


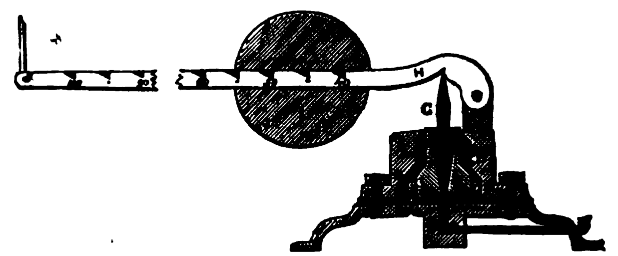
Fig. 3.

This invention is intended to remedy the defects of the old joint of drain-pipes in use up to the present time, complained of generally in consequence of the stoppages. These are found to take place by the accumulation of the more solid part of the refuse at the joints. In the old pipes, there are two causes which create accumulation of solid matter: either, first, a lateral opening of the lower part of the joint, by which a crevice is formed, wherein any small solid may fasten, and thus becomes the nucleus for an accumulation of solid refuse; or secondly, a vertical settlement of the upper pipe by undue pressure on the cement or mortar used in the joint. In order to render the difference plain to our readers, we have engraved vertical sections of the old joint at present in use at fig. 1; of a portion of Mr. Jennings's patent improvements in the connection to drain-pipes at fig. 2; and the patentee's improved wedgeular joint at fig. 3. The old joints, including Mr. Jennings', are all rectangular, that is to say, their angles, as at A and B, fig. 1, are all right angles. The consequence being, that in the old pipe (fig. 1) the inner pipe has to be supported by the cement in the lower cavity C, presses on the same, and the result is, the depression of the inner pipe, and a raised shoulder at A, which acts as an impediment to the direction of the flow. When a lateral opening takes place, a vertical cavity or crevice is the result. The combination of a lateral opening or crevice with a vertical depression of the inner tube must be the means of choking the drain in a very short time. Mr. Jennings' invention does not obviate the lateral opening, which may be double in the case of his saddle, as he has a double joint instead of a single one, but remedies the possibility of a vertical depression by allowing the ends of the pipes to rest on the shoulders of an intermediate saddle. In fact, it is the old joint (as will be seen by a reference to fig. 2) without the cement or mortar space shown in the old joint in fig. 1. Besides the double transverse joint of the saddle, there are longitudinal joints, one of which is shown at A B, to connect the lower saddle with the upper one, the length of joint being thus three times as great as that of the old pipe; and as there is no allowance made for cement space, unless the whole of the saddle be imbedded in concrete, we are at a loss to know how the escape of the gases is to be prevented.

The improved wedgeular joint shown at fig. 3 is intended to remedy the evils of both a lateral opening and vertical depression. Instead of making the joint rectangular, Mr. Rovère has secured the right to substitute an oblique joint, which prevents the possibility of the objectionable vertical crevice taking place, and also thereby supports the inner pipe D, and prevents effectually any pressure on or compression of the cement or mortar in the lower space C, which is thus allowed to harden at the same density throughout the circumference of the joint. To prevent the escape of gas, and obtain an air-tight joint, Mr. Rovère proposes to introduce a thin coat of cement or creosote between the surfaces of the wedgeular joint A B, when the pipes are being fitted. The means thus afforded of supporting the inner pipe and fitting the joint permanently while the cement or mortar remains wet, enables the laying to be effected in much less time, and with certainty. The length of the joint remains at its minimum, as in the case of the old joint, fig. 1, and no additional pieces are required.

## REGULATOR FOR STEAM BOILER FIRES.

P. Clark, U.S. *Patentee*, January 3, 1853.



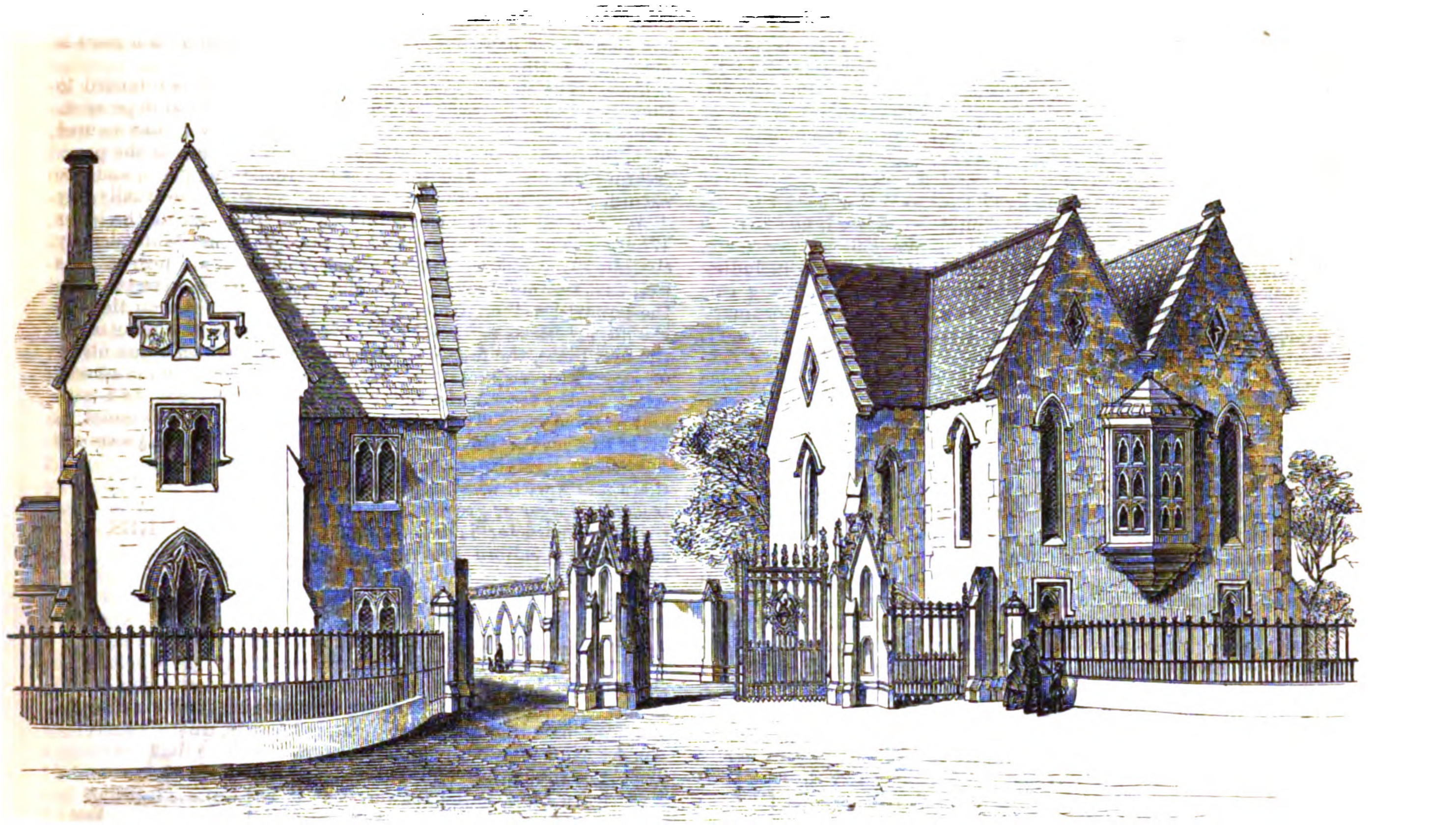

The annexed engraving is a view of an improvement in regulating the dampers of steam-boilers by the pressure of the steam. This invention consists in causing the damper in the chimney (or if a blower is used, the damper for shutting off the blast), to be acted on by the pressure of the steam, so that when the head of steam in the boiler has attained the pressure required, the damper will be closed, but when the pressure is less than that, say by one pound per square inch, the damper will be opened.

A, is a base of cast-iron, on which is fastened by means of screw bolts, the cylinder B, which is also of cast-iron. C, is the pipe leading from the boiler, connected with the cylinder at D. The pipe C, is bent like a syphon, to prevent the steam from coming in contact with the diaphragm E. This diaphragm may be made of vulcanised india-rubber, or any flexible substance, having considerable strength and being impervious to water. It is made cylindrical in form, of a length sufficient to allow of the piston F, moving through any distance required; and is surrounded by a flanch about one inch wide, which answers the double purpose of holding it to its place, and making a tight joint between the flanch of the cylinder, and the top of the platform upon which the cylinder rests.

The bore of the cylinder must be as much greater than the piston as will allow the diaphragm to expand in the chamber S. The piston F, fills the upper part of the cylinder B, loosely, and has a hole bored nearly through its axis from the top to receive the bar G. The bar is smaller than the hole in which it stands, to allow of its accommodating itself to the varying position of the lever H, which rests on the top; I, is a ball or weight made to slide to and fro on the lever. It is used to counterbalance the static pressure on the bottom of the piston; K, is a rod connecting the lever H, with the crank of a damper. The machine as described in the foregoing being put in connection with the boiler and damper, the piston will be acted upon by the pressure of the steam, and when the weight of the ball on the lever H, is little more than counterbalanced, the lever will be lifted, thereby closing the damper; of course, if the pressure now diminishes a little, the weight and lever will descend and open the damper.

## THE ST. PANCRAS AND ST. MARY'S (ISLINGTON) EXTRAMURAL CEMETERY.

Messrs. Barnett and Birch, *Architects.*



Some time since we illustrated the chapels erecting in the grounds of this by far the most extensive parochial undertaking, at present being carried out by the joint parishes of St. Pancras and St. Mary, Islington, under the provision of the New Burial Act. Our present engraving represents the principal entrance erecting in the high road from London to Barnet. The right-hand house consists of porter's lodge, office, and waiting-rooms, &c., on the ground-floor, and above is a large board-room, with the necessary offices attached thereto. This floor is connected with the ornamental terrace beyond, which is proposed to be used for monumental tablets, &c., and a public promenade, with flights of stone steps from the ground, at either end.

The other lodge is not erected, but is designed for the residence of the officiating clergyman, or the registrar and overseer of the cemetery, according as the Board may ultimately decide. The whole extent of the grounds is eighty-eight acres, and the various works under the direction of the architects, Messrs. Barnett and Birch, are fast progressing, in order that they may be completed by the latter end of July next, the time appointed by the Bishop of London for consecration.

## FILTRATION OF WATER.

By S. Trotman, Hydraulic Engineer.

The steady, unmistakeable signs of the approach of that deadly scourge, the Cholera, render it the paramount duty of all who can in any way direct attention to preventives and curatives, to lay such before the public eye, that at least the opportunity may be given for the avoidance of any course that may endanger the public safety, and the finger-post erected directing to wise measures, which, we conceive, are blessed by an over-ruling providence to the lessening of the fatal influence of this fearful visitation.

The most prominent sanitary *ignis fatuus* of the present day, and one the public devotedly follow, risking health and almost life in its pursuit, is that of a promised supply of pure water by the various metropolitan companies, on whom we are dependent for this invaluable element. And though it is somewhat surprising that science has not done more towards removing the apparent impracticability attendant on the supply of pure water, it is still more a matter to be wondered at and regretted that the public has not yet been directed to the best mode of obtaining the nearest approximation to the desired reality. In the *Times*, September 1853, on the "Laws of Cholera," is found the following important paragraph:—"People owe it to themselves and the establishments over which they have control, to secure an ample supply of water which has been filtered chemically as well as mechanically, having passed through charcoal (animal charcoal is the best), as well as through porous stone or gravel." We think this paragraph a good moral to the old fable of "Hercules and the Wagoner," and we only regret that a more detailed description was not given to those who would gladly have availed themselves of it.

It is our purpose, in the first place, to show, that although filtration by our companies is most needful, and the absence of it most reprehensible, yet it is a moral impossibility to render water, by their *present system* of filtration, sufficiently pure for human consumption; this therefore necessarily devolves upon the consumers themselves.

We next purpose to show, however good in themselves any media of filtration may be, yet, if improperly adapted (as is almost universally the case in the present day), all such embodiments commonly called filters are a source of trouble, expense, and vexation to those who use them; and that if a proper medium be properly adapted, a filter may be rendered indestructible by wear, automaton in its action, and free from any liability to become fouled or impregnated by the gross matters which it is destined to separate from the liquid to be filtered; and it should be a *sine quâ non* that all apparatus for filtration should be rather repellants of sedimentary matter than absorbents of and receptacles for the same. We wish it to be understood, that we merely intend to lay down the scientific principles upon which all filtering apparatus should be constructed and adapted. We have asserted that it is a moral impossibility for the companies to filter the water supply of London so perfectly as to render it fit for human consumption by the agencies at present employed; and we will venture to assert still further, that even if, at an enormous outlay, the filtration were rendered perfect, obstacles of an insurmountable character present themselves to the purification of the water by chemical agency, so as to deprive it of its poisonous constituents, and to render it really pure. The reasons, we think, will be obvious, on referring to the statistics of one of the larger companies. The daily supply from the company's main is four million gallons, or an average allowance of twenty-five gallons to each individual. Now, if we analyse the mode of consumption it might be rendered thus:—Water used for purposes that render it necessary it should be filtered, five gallons per diem; water needing no filtration, five gallons per diem. This is the average allowance for each individual, not including that used for manufacturing purposes or trade. Allowing this to be a fair average quantity, what becomes of the extraordinary overplus of fifteen gallons per head per diem? The answer is simply this, that it is wasted. Whilst this extraordinary proportion is run to waste, we cannot hold the companies responsible for the delivery of the water in a pristine state. Taking a pecuniary view of the question, the perfect filtration of four millions of gallons per diem would entail an outlay of eighty thousand pounds, the interest of which, rental of ground, staff employed, with necessary repairs and contingencies, would not amount to less than five thousand pounds per annum. Admitting that four-fifths only of the above water supply really demands filtration, we have a needless expenditure of sixty-four thousand pounds; or, in other words, the sum of four thousand pounds per annum would be expended in producing the most unsatisfactory results; and we conceive that the question is only to be met by the public providing for their individual establishments the necessary apparatus for filtration, adopting such measures as shall ensure an ample supply of water in a state of purity, not only as a beverage, but also for culinary purposes.

We have thus endeavoured to show in a few words our reasons for supposing that the water companies will not consent to any kind of filtration beyond that of passing the water through beds of gravel or other loose materials, which filtration is far from sufficient to purify the water for human consumption, such filter-beds allowing free passage to the spawn of the mollusca and zoophyte tribes, which is alone sufficient to condemn any such medium. The various methods now employed for the purification of water may be classed under three heads—mechanical, such as straining, usually termed filtering; chemical means artificially applied, such as antiseptic media, of which animal charcoal is by far the most effective; natural chemical means, such as oxidation or neutralisation by the ozone of the atmosphere, or by peculiar chemical combinations oxidising and precipitating the impurities. One of the methods employed for defecating water consists of an apparatus called the thunder-pump. This pump, rigged to a considerable height, throws down the water to be purified in a complete spray, thus bringing its particles infinitesimally in contact with the oxygen of the atmosphere. The mode of purifying the water of the Nile by precipitation is worth notice. A native woman provided with a handful of mish-mash, or the rind of a peculiar kind of apricot, violently agitates the water in a large receptacle, when a precipitate is thrown, and water, before turbid and unfit for use, is thus rendered quite drinkable.

It is evident, that any perfect method of purifying water should be rendered independent of all manipulation, and that the apparatus used must be self-acting. By self-acting we mean not for a month or two, but constructed on such principles that a collection of obstructive matter shall be impossible, and that the water to be filtered shall not become charged with the impurities of the preceding permeation.

It needs no stretch of mental exertion to comprehend the fact that the most perfect medium of filtration may be rendered useless by an unskilful adaptation. Leaving for the present any remarks upon the merits of the various mediums in general use, let us suppose we have one of a perfect character, with which the impurities of the water cannot amalgamate, and in itself not capable of decomposition; obstruction is then the only thing likely to interfere with its effective working. A most valuable medium of filtration—we speak of the artificial porous stone—has suffered much from this very cause, owing to the erroneous adaptation of the material. On the principle of *descension*, it is evident that if the medium refuse to absorb the impurities, they must remain on its external surface, and thus, as the water in its pure or cleansed state finds its way through the medium, the detritus separated from it necessarily becomes an obstruction to subsequent permeation, rendering ultimate stoppage, however slow, not the less certain. Now, suppose this same medium on the principle of *ascension*, the water rising to find its level, and permeating through the medium, leaves the gross particles behind. The more dense these particles, the more rapidly do they fall from the surface for permeation to the bottom of the receptacle in which it may be placed; and thus it will be seen, that the very law necessitating the fall of the detritus and creating an obstruction on the *descension* principle, assists the natural separation of the water from the detritus, and the immediate removal of all obstruction in the principle of *ascension*. Where it is a matter of expediency that the *principle* of *descension* shall be employed, we should rather choose a medium of filtration that became choked, from the fact of its refusing to admit the impurities, than a medium of such material as would allow the impurities to enter into combination with its particles. In the first place, the fact of choking indicates that an accumulation of impurities requires removal; this can be readily effected; while, in the second, the water may be rendered doubly impure, and in some cases even poisonous, from the decomposition of the gross particles retained. As an illustration, let us take an ordinary filter. Impure water is poured into the upper section; it there meets with what might be called scavenger No. 1, holding back the larger or grosser particles. Next, a stratum of a less pervious character is reached by the water, and particles of a second-sized calibre are retained by scavenger No. 2. The infinitesimal impurities are now supposed to be held back by a yet more dense and compact medium, performing the duty of scavenger No. 3. We have now to deal with the subtle combination of impurities held in solution, and here the case is met by a barricade of vegetable carbon occupying nearly the whole of the space illusively supposed to be devoted to the reservation of pure water. As experience has shown that this is not only a chemical, but a mechanical strainer, we must, in honesty, call this scavenger No. 4. Now comes the question, how do these four scavengers dispose of the impure and foul material they have thus retained? Experience supplies the answer, that it has become more or less amalgamated with their own substance, and can only be removed by taking the whole apart, and washing the several layers of which it is composed. Artificial porous stone takes the precedence over loose materials, and possesses this advantage, that it can never admit the impurities into its own substance; and being a silicate, is not liable to decomposition or decay: but with this material, perfect as a medium of filtration, we have an instance illustrative of the condemnatory effects of mal-adaption; for, admitting that the impurities cannot pass through the stone, have we not the impurities on the stone acting as obstructives, thus preventing the permeation? whilst, on the other hand, if adapted on the ascension principle, as we have before described, neither months nor years of permeation will influence the material in any way to reduce its daily yield. And more forcibly still is the value of this principle demonstrated by the fact, that an area of one foot superficial, yielding but one hundred gallons per diem on the principle of descension, under the same head of water has been known to yield from five to six hundred gallons per diem, on the principle of ascension. We would further remark that all apparatus designed for the purification of water should, if at all practicable, be immersed in the tank or other receptacle from whence the ordinary supply is obtained, in order to ensure the valuable desiderata of freshness and low temperature—such apparatus also filling themselves, yielding a far larger supply of water, and being free from breakage.

We hope the day is not far distant when filters will no longer hold the anomalous position they now occupy; but cheapness and perfection being combined, it will be a matter of ease as well as expediency for each one to provide for his own establishment an ample supply of pure water.

*Supply of Cannel Coal Gas in the City.*—At a recent meeting of the City Commissioners of Sewers, a letter from the Great Central Gas Company was read, stating their wish to take up, at a future time, the pavements in the streets of the City, to lay down new mains for supplying Cannel coal gas to their customers. After some discussion the matter was referred to a committee.

## ON THE DRAINAGE OF BUILDINGS AND STREETS IN THE METROPOLIS.

[*A Discussion held at the Royal Institute of British Architects.*]

(*Concluded from page* 208.)

Mr. FOWLER observed, that although there existed much greater activity and efficiency in house and street drainage, the result was, that the Thames was rendered a much greater source of annoyance and pestilence. He denied that the sewage matter was sufficiently diluted to be inoffensive, stating that the sewage, being lighter than the main body of the water, floated upon the surface, and was deposited at ebb-tide on the shores. But although this matter was offensive, it was valuable as a fertilising agent. Various schemes had been proposed for recovering the manure, but had not succeeded as commercial speculations. He further stated, that at the present time Mr. Wicksteed, Engineer to the East London Waterworks, is engaged in a very large speculation of this kind at Leicester. Another plan proposed was, to convey the sewage water by main pipes into the country, and then to distribute it over the land. With respect to the views of the government, to whom the decision of the question must eventually come, Lord Palmerston had declared that they would consider no general plan for the drainage of London effective which did not provide for saving the river from pollution, and at the same time preserving the products of the sewage for fertilising the country. If this were the right principle, it was obvious that the sewage should be carried by the shortest and most easy courses into the country direct; and therefore the majority of the plans proposed, suggesting as they did the concentration of the sewage at a spot some distance down the river, had a tendency to obstruct that principle, and were therefore unadvisable. Further, as these plans are proposed to make the Thames the receptacle of the sewage, both of the principles laid down by Lord Palmerston would be violated.

Mr. MOREWOOD, representing the Great London Drainage Company, stated, that the question before the meeting was the "outfall" for the drainage of the metropolis, and as the Board of Health plan dispensed with all the present arrangements, and consequently with the necessity for an outfall, it might be well to say a word in reference to their plan, as recommended by Mr. Fitzroy to the Metropolitan Commission of Sewers, which had been ascertained to be identically the same as that which the Sanitary Commission advocated in 1848. It consisted of "liquid distribution of sewer water," of "pipe-sewers" and "pipe-drains." Liquid distribution had been advocated for ten years, and was specially in favour in Greek-street in 1849, and yet up to this time there was not one instance of its being used in any one of the towns under the Board of Health. In fact he declared it to be entirely fallacious, and that it never could be carried out profitably. As to pipe sewers: Sir Christopher Wren built a sewer 20 inches by 14 from Cripplegate to Bridgewater-square in 1691, and in 1714 it had to be taken up and rebuilt 4 feet by 2 feet. Mr. Kelsey, the late very able surveyor to the City Commission of Sewers, stated, "it is not in the least improbable, that if drains and sewers are so wire-drawn as barely, and that with the most unremitting attention to their cleanliness, to suffice for the ordinary discharge of the foul waters of houses, and of ordinary showers of rain, another generation will not pass away before another re-modelling of such matters will be found imperatively demanded, as one may with tolerable certainty predict, that if sewers should be built into which a man cannot get to examine and repair as time shall gnaw them away, the evil day must and will come when the whole will have to be re-constructed." In reference to reducing the optional sizes of house drains to 12 by 9 inches, he said, "with what advantage or detriment time will show," and the very words which he used in respect to stoppages and failures were the same as those used in a report from the Board of Health in reference to Croydon. In cleaning the obstructed sewers, however, it has generally been found that the stoppages, whether in 4 or 6 inch pipes, have occurred from substances which ought never to have gained admittance to the sewers at all. From Mr. Simpson's evidence in 1846, it appeared that the Chelsea Waterworks Company had laid down a quantity of earthenware pipes, which, after a few years, had a dull sound when struck, and when they burst might be crumbled with the hand. At Croydon, some of the pipes were found to have become softened, and there was ~~moreover the Metropolitan~~ Commissioners' report of failures, with a vast number of illustrations. The Board of Health plan of liquid distribution of sewer-water of pipe sewers and drains was therefore entirely inadmissable. The recognition of that which the metropolis requires—a lower outfall than the Thames—was to be found in a pamphlet in 1839, emanating from an architect, who, after showing the existing levels in Westminster, states that it is quite impossible for the Commissioners of Sewers to remedy the evils complained of. They had for years past endeavoured to palliate the mischief; all the sewers in Westminster, for twelve hours out of the twenty-four, were merely cesspools or reservoirs, the mouths being closed by sluice gates; indeed, were it not for these gates, every house in Westminster, even those in Park-street and James-street, would at high tides be inundated with the filthiest of floods. In 1846, Mr. Donaldson gave very decided evidence in reference to the inefficiency of the present outfall into the Thames, and showed how readily the Westminster Commissioners of Sewers were availing themselves of the temporary lower outfall caused by the removal of old London-bridge; and in 1847 Mr. Wm. Hosking, in a postscript to his work, strongly warned the government against further clogging the sewers and the Thames, "unless the refuse can be certainly hurried on through the sewers, and in a diluted state to an *effective outfall.*" This lower "outfall," this removal of the sewage, Mr. Morewood considered, could alone be effected by the drainage plan with which he was connected, commonly known by the name of the Great London Drainage, which consisted of two tunnel sewers extending on each side of the Thames respectively, from Chelsea and Vauxhall to the marshes east of London, the sewers running under the streets and roads, as the Strand, Fleet-street, &c., to be made by tunnelling, and to be laid with an artificial or additional fall, so that the sewage might be passed away from the metropolis and pumped up at the terminal works, there to be formed into a dry manure, the refuse water being thrown on the top of the tide. He stated that this drainage plan had been prosecuted in the session of 1848, when it had been very favourably entertained by the government, but it was most unexpectedly stopped at the second reading on the 7th March, 1848. In 1853, the proposed works and estimates had been proved before a select committee of the House of Commons, and the minutes of evidence printed by the House, with a view to future legislation, and the chairman of the committee had stated to the House, that *they had fully approved* of the works proposed—viz., two tunnel sewers to deliver the refuse below the town. In reference to the Metropolitan Commission of Sewers, Mr. Morewood stated that their own report to parliament in 1851, fully identified them with these very works; the tunnel sewer on the north side being described as from Chelsea "to the pumping-station on the river Lea," and that on the south side as a "system of sewers between a point near the top of Woolwich Reach and Vauxhall, the main line and branches comprising upwards of thirteen miles." A report from the surveyors of the Metropolitan and City Commission of Sewers entirely approved of the line of those sewers as proposed by the Great London Drainage Company, declaring, in reference to the north side, that it was in some respects better than the alteration adopted by the Metropolitan Commission (in 1851); and respecting the south side, "the general levels of the district, as well as the levels of the inverts of its sewers, are such that the interception of the sewage can be effected by either scheme." Respecting high-level sewers, by which the question has since been complicated, they expressly said, "and it would in our opinion be found necessary at some future day to construct upper lines of intercepting sewers." The point of difference with the Commissioners was the guarantee of a contingent interest of 3 per cent. for twenty-five years; and also, the Commissioners, not having taken into their calculation that the tunnel sewers were never intended for Richmond and Croydon; that evaporation amounted to 32 inches when the rain-fall was 27 inches; that absorption materially reduced the quantity of rain water to be provided for by tunnel sewers; and that immense storage room was already in existence for storm waters, which would pass through the present channels into the Thames, when the quantity of ordinary sewage, ten or twelve million cubic feet, exceeded the thirty-seven millions for which the two tunnel sewers provided.

Mr. G. R. BURNELL, in reference to the deodorising of sewage water, alluded to the works which had been carried on at Cardiff, and said that Professor Way had informed him that there was a great difference between the sewage water of large and small towns, and that the sewage of London, when it had passed through great length of sewer, and arrived near the outfall, had lost so much by evaporation that it contained very little indeed of really valuable matter available for agricultural purposes. Seven years ago he had visited the works near Chelsea referred to by Mr. Fowler, and although they had been highly eulogised at the time, he found that they did not distribute sewage water at all, but merely the water from a canal.

Mr. Fowler explained that that had been the case only in the commencement of their operations, the main was afterwards laid into the wall. Mr. Burnell had been misinformed; in 1852, the company distributed a great quantity of sewage water.

Mr. Burnell considered the general question to be purely of an engineering nature, and that the Home Secretary was travelling out of his path in deciding that an uniform system should prevail, when in fact nothing was clearly known upon the subject; and scientific men declared that the sewage of small towns was fit to be profitably used, whilst that of large towns was not.

Mr. Fowler believed that the government merely asserted a general principle, which did not involve any engineering question. It was simply a question of economy, and one that might be properly taken up by the government. They had not gone so far as to dictate any particular mode of carrying out their principle. Mr. Fowler added, that the discharge from the King's Scholars' Pond sewer had been found to possess fertilising qualities in a very high degree.

Mr. Haywood observed, that if the treatment and recovery of the sewage could be made to pay 5 or 6 per cent., small manufactories might be established at the mouth of every sewer. If the drainage was not to flow into the Thames, intercepting sewers were necessary; and if, though flowing into the Thames, its reflux was to be prevented, it must be carried sufficiently low down to prevent its returning with the tide. With regard to irrigation with sewage waters, he had no doubt of its advantages, but questioned whether it could be made to pay. The magnitude of the drainage of London (amounting, exclusive of rain, to 12,000,000 cubic feet of water every twenty-four hours), was a serious obstacle to any purifying scheme, but even that would be surmounted if it would pay 5 per cent. The plan of intercepting sewers had no particular novelty; its supporters considered that the chief fault in the plan of the Great London Drainage Company was, that it was not sufficiently comprehensive, and did not allow for the extraordinary influx of storm-waters. They also objected to the pumping on Mr. Morewood's plan, preferring drainage by the natural force of gravitation as a cheaper system, and less liable to accidental interruption. Messrs. Bazalgette and Haywood proposed to discharge the sewage at Woolwich only with the first two or three hours of the ebb-tide, in which case none of it would return so high as the point at which it was discharged. The sewage was an infinitesimal quantity compared with the water of the river, and far less injurious than the public imagine. Four minutes of ebb-tide at London-bridge would suffice to carry down all the real fæcal matter of the twenty-four hours, if collected, and much of the effluvium which arose at low water was in consequence of the sewers discharging their contents upon the shore, instead of being conveyed by culverts to parts below low-water mark. Mr. Haywood considered 50,000*l.* would be well-spent in determining the value of this matter when relieved of 700 times its bulk of water. All the illustration of its value had been drawn from places where its dilution was not one-third or one-sixth so much as in London, In Edinburgh, the distribution of the highly-concentrated matter over the country had become a fearful nuisance, but it had been argued, that in London all the smell would be lost in two minutes and a-half.

Mr. Austin produced a drawing of his proposed plan of sewerage,* which consisted of a large tunnel below the streets, 26 feet in height by 18 feet in width, providing at the same time space for gas and water pipes, and a tramway for connecting the different lines of railway. He also produced a plan of drainage by means of two tunnels under the bed of the river on each side, proposing that only the flood or rain water should pass directly into the Thames.

Mr. Garling read an extract from a letter written by himself in 1824, in which he proposed intercepting sewers, thus showing that he originated that idea at an earlier period than John Martin, to whom it is generally ascribed, and that his (Mr. Garling's) views were then similar to those of Messrs. Bazalgette and Haywood.

Mr. Morewood observed, that a very similar plan had been suggested by Mr. Dodd fifty years ago. He stated that the Great London Drainage Company contemplated the formation of high-level sewers in addition to low-level sewers, as the size and population of London increased, and that their plan was fully adequate to provide for the ordinary rainfall in the metropolis.

After some further unimportant discussion relative to pipe sewers, the question was brought to a close.

* The proposition of Mr. Austin is in most respects identical with that of Mr. John Williams, who obtained a patent for sub-arch railways in 1822, but as his ideas were rather crude and undigested they failed in obtaining the attention they deserved.—Ed. C.E. & A. Journal.

## THE CANADA WORKS, BIRKENHEAD.

The land on which the Canada Works are erecting at Birkenhead is of an irregular form, and the buildings 900 feet long by 36 feet wide. The land abuts on Wallasey Pool, near the bridge. Mr. G. Harrison, manager of the engineering department (formerly a resident in Birkenhead), arrived a year ago from America, to initiate and conduct these works for Messrs. Peto, Betts, Brassey, and Jackson. The progress of the works has been most rapid in every way, as within a year they have been erected, and two engines built and shipped.

There are 400 men at work in the engineering department, and 123 in the bridge-building department, and the latter is to be considerably increased. Of what are technically termed "pits," or places where engines are built, there are ten, and there are five passenger and five goods engines in course of construction. The works are able to manufacture forty per year. The railway will require for its own uses this rate of manufacture for the next seven or eight years, or 300 locomotives. All the work, except the tubes and some smaller matters, is made on the premises; and it is an interesting sight to see a place which but twelve months ago was a piece of waste land, covered with buildings and railways, and the ground strewed in all directions with boilers, tenders, wheels, engine-frames, and the other parts of locomotives. There are two modes for shipment of the engines when complete—one by water, 20 feet deep, at the back of the yard, and the other by the dock railway, which runs into the workshops.

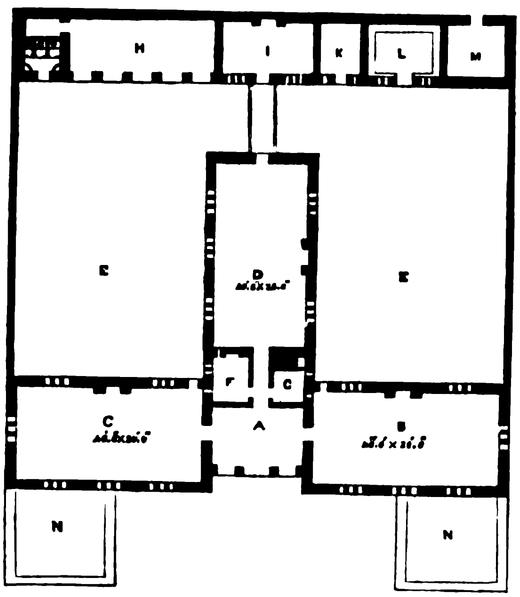
On the opposite side of the yard is the bridge department, for the construction of the great tubular bridge to cross the St. Lawrence, which is similar in design to the Britannia, but immensely larger. It is making in a shed 215 feet long by 48 feet wide, and one span of 155 feet has already been shipped. There is a 35-horse power high-pressure engine in this shed. In this department, the iron is delivered by railway, and the plates are rolled, punched, and subjected to such manipulations as will prepare them to be put together when they arrive out at Canada. The parts are so numbered and packed that when they arrive out there will be no difficulty in riveting them together.

The first engine made at the Canada Works, Birkenhead, was subjected to a trial on the 29th of May, previous to shipment for the Great Canadian Railway. The engine, which is the first locomotive engine made in Birkenhead, was built as No. 1, and each successive engine will be numbered onward. It was named after Lady Elgin, Mr. William Jackson, M.P., christening it. The second will be called the Lord Elgin, and both will be despatched by the steam-ship *Ottawa*.

The railway is between the narrow and broad gauges in width—viz., 5 ft. 6 in., which will make the carriages more commodious, and add greatly to the steadiness of the trains. The engine has a cylinder 15 inches diameter, and 20 inches stroke, with driving and trailing wheels, the latter 6 feet diameter, and the leading-wheels 3 ft. 6 in. diameter. The engine is tubular, having 178 tubes, each 1⅞ inch diameter, which is equal to 872 feet of heating surface. In the fire-box the heating surface is equal to 78 superficial feet; making a total of 950 superficial feet of heating surface. The American principle of a "spark-catcher" has been adopted, as the steam will be generated by wood fires, which throw sparks up the chimneys, and which require to be intercepted, so as not to damage or set fire to the forests through which the engines travel. This engine will be able to take twenty-two or twenty-three carriages forty miles an hour. The principals of the establishment celebrated the event by dining together at the Woodside Hotel.

## ERRIS FISHING SETTLEMENT, MAYO, IRELAND.

T. C. Tinkler, Esq., *Architect.*




In September 1849, the Erris Fishing and Industrial Settlement was commenced, with the view of employing the boys of the peasantry in various labours, and of imparting to them a sound education. Boys from ten to sixteen years of age are instructed in the improved modes of deep-sea fishing, the manufacture of fishing nets and lines, boat-building, and agriculture. The Erris coast is peculiarly adapted for these purposes, having "good, capacious harbours, excellent anchorages, sheltered from all winds in bad weather; a port, the egress and ingress to which is unattended with danger, and always under the lee with the prevailing winds; and also an abundant supply of fish." The canal between Blacksod and Broadhaven is also an advantage which most other places do not possess.

The Society has therefore been happy in its selection of a site for their establishment, which is represented in the annexed engravings.. The main body of the building, as at present existing, is of a T form; the central building is higher than the others, and has a belfry on the roof ridge, and an open porch in front. In the ground plan, A, is the porch; B, school-room, 40 feet by 20 feet; C, the dormitories, of the same dimensions; D, is the dining-hall, also 40 feet by 20 feet; E, E, are the open yards; F and G, the master's rooms. At the rear of these buildings is a range of offices, consisting of a working shed H; kitchen I; scullery K; lavatory L; and cow-house M. The two portions of the front buildings marked N, are not yet in existence, but will be erected as soon as the Society's funds admit.

The institution is well worthy of support, and, from the practical nature of its endeavours, is likely to ameliorate the position of the Irish peasant in that respect, as well as to render service to distressed vessels on that portion of the coast.

## WATERFORD AND KILKENNY RAILWAY.

### Engineer's Report.

From an examination of the works throughout the line during the past week, I am enabled to submit the following report for your information. In my last half-yearly report, dated 21st November 1853, I anticipated that the Waterford end of the line (which is being constructed by the Waterford and Limerick Railway Company), would have been completed early in the present year, but I am sorry to say that, owing to a very reduced rate of progress in the works taking place shortly after the date of my report, as well as from the unexpected difficulties which ensued by the sinking of the embankment through the marshy lands, my expectations were not realised, and the line is yet incompleted. During the past fortnight, however, Mr. Dargan, the eminent contractor, has employed a very large number of additional workmen on this part of the line, and it is evident that the greatest exertions are now being made so as to complete the works and station within the shortest possible time. On a great length of the line nearest Waterford, the Limerick Company has commenced the laying of the permanent way of their line, and as the permanent way of the Kilkenny line is to be executed by your Company, it is necessary that immediate steps should be taken for carrying on the same contemporaneously with the works of the Limerick Company; otherwise that Company will be in a position to complete their line into Waterford before you. Judging from the present activity in the works, with long days and summer weather, I have no doubt that the Waterford end may be completed by the first week in July next. On Saturday last, I very carefully examined the timber superstructure of the Nore viaduct, accompanied by your resident engineer. On comparing the levels of this work, as recently taken by Mr. Atkinson, with those previously observed by him from time to time, I find that the rate of deflection in the curvature of the lattice framing has not increased during the past year; and therefore for your guidance, I may remark, that, if the same rate of deflection should continue as it has done during the past three years, it would occupy a further period of seven years from this time before the framing would arrive at a horizontal line, and consequently there is now no cause whatever for supposing the viaduct to be in danger. The original defect in the construction of this superstructure by not trenailing the lattices together, causes considerable vibration throughout the work on the passing of the trains over it, which motion necessarily tends to compress the joints of the lattices where they pass through the horizontal beams, and hence the case of a slight deflection in the structure constantly going on. In my report to your board on the 25th February 1852, I pointed out this defect in the work, and it was afterwards explained to Captain Moorsom, who considered it was then too late to insert the trenails, more particularly as he expected at the time that the structure was then near a point of rest. I am of opinion that such an additional mode of fastenings to the lattice and horizontal timbers would prevent a great deal of the present vibration in the structure, the parallelism of the horizontal beams would be maintained, and the whole of the framing would be thereby made a perfect and complete truss, and I feel persuaded that the rate of deflection would be greatly reduced. The cost of the trenails I estimate at about 100*l.* Beyond the insertion of these fastenings I do not think it would be advisable at present to incur any other important expenditure on the work, for the structure cannot be considered otherwise than secure for seven years to come, at least, and it is very probable before that time a great deal of the timber in the framing will require to be renewed, so that I consider it would be advisable not to incur any large outlay on the present viaduct, but hereafter to substitute a substantial as well as durable structure; more particularly when it is considered that it would require a large sum of money to make the present work permanent. On the 13th inst. the contractors, Messrs. Ellis and Husler, delivered up the maintenance of their contract, so that now the works of the entire line are being maintained by the Company's workmen, and under the superintendence of your resident engineer. The permanent way is maintained in good and efficient working order. The roof of the passenger shed at Kilkenny has been recently painted, and the platform of the station thoroughly repaired. The working gear of the four locomotive engines that were last delivered have recently undergone a thorough overhauling and repair, so that the engines are in excellent condition.

*May* 31*st*, 1854. Charles Nixon, C.E.

## ON THE SYSTEM OF DRAINAGE PURSUED IN THE METROPOLIS.

REPORT *to Viscount Palmerston, upon the System of Drainage Pursued in the Metropolis.* By RICHARD JEBB, Chairman of the Metropolitan Commission of Sewers.

MY LORD—Having received your Lordship's instructions to furnish you with my observations with reference to the Reports from Rugby, Sandgate, Tottenham, St. Thomas's Exeter, and Barnard Castle,—copies of which were transmitted, by your Lordship's directions, to the Metropolitan Commissioners of Sewers, on the 8th and 26th of November last;—also, with reference to Mr. Fitzroy's letter on the 18th ult., conveying your Lordship's opinion that the system recommended by the Board of Health is that which ought to be adopted, as combining the greatest degree of efficiency with the greatest degree of economy, and transmitting a copy of a letter from Mr. F. O. Ward;—and generally, with reference to the respective merits of the two systems:—

I beg, in the first place, to apprise your Lordship that, by order of the Commissioners, their Engineer Mr. Bazalgette, visited the five towns above referred to, and in his Report* are embodied the results of his observations with regard to the nature and expense of the works there executed; those results being such as to qualify the conclusions which might, without explanation, be drawn from the Reports of the Local Boards of the places named. From his Report the following facts may be collected: that in each of the five towns there is a double system of sewers,—1, a set of old brick sewers originally constructed for surface drainage, and now maintained for that purpose out of the public rates; 2, a set of newly-constructed pipe sewers, chiefly or exclusively for the reception and discharge of house-drainage. The entire sewerage of the town comprehends both sets of sewers; and its cost is really the cost of both, and not the cost of the new pipes merely, as a person deriving his sole information from the Reports sent to your Lordship might possibly suppose. I may here remark, that a like observation applies to several other places drained under the supervision of the General Board of Health, where pre-existing brick sewers are still maintained, and used as a part of the system of sewerage; whilst the Reports, holding up the drainage works in those places as models of cheapness, make mention only of the new works.

At St. Thomas's, Exeter, as respects a considerable part of the town, the average cost per house of putting in house drains, &c., would appear, on the face of the Report from that place, to be exceedingly low. This apparently low average is obtained by dividing the entire cost of all the house drains amongst the houses, whether drained or *undrained*. Mr. Bazalgette estimates the proportion of the undrained houses at about half the entire number.

It further appears from Mr. Bazalgette's Report, that the cost of executing works of the same character is necessarily greater in London than in the five towns referred to. This arises from two causes:—First, all kinds of workmanship are dearer in London than in country towns. This observation cannot apply to Tottenham, but it applies to the other places. Secondly, and chiefly,—in London there are several heavy items of expense, which either do not occur at all, or occur in a very slight degree in country towns. In London, sewers, whether of pipes or of brick, must generally be laid at a much greater depth; the trenches carefully fenced, watched, and lighted; the large and weighty and closely packed houses shored up; gas and water-pipes protected and made good; and costly pavements removed and restored. These, and like matters, add very materially to the expense of making sewers in London; and the amount is but little affected by the nature of the structure.

It is important to observe, that the cost of sewering a town is not simply in the ratio of its size. Thus, the sewerage of a town of 100,000 inhabitants will cost more than that of ten towns of 10,000 inhabitants each, because the accumulated sewage of the higher parts must be conveyed through the lower parts, demanding an enlargement of the sewers of the latter, beyond their own special requirements. I will here give the population of the five places particularly in question:—

| | |
|---|---|
| Tottenham | 11,000 |
| Rugby | 8,000 |
| St. Thomas's, Exeter, excluding Exwick, whose drainage is entirely distinct ... | 5,300 |
| Barnard Castle | 4,600 |
| Sandgate, besides a fluctuating population of uncertain amount, resorting to the village in the bathing season ...... | 1,400 |
| Total | 30,300 |

As to the alleged efficiency of the works: from Mr. Bazalgette's Report it appears that in none of the five towns named have the works of *private* drainage been commenced more than two years and a half; in some they have been commenced much more recently; and in none are they yet complete. In none has sufficient time elapsed to give the system a full trial. In four out of the five towns there have been failures; at Sandgate to a considerable extent.

Adverting now to Mr. Ward's letter, of which I append a copy for the convenience of reference,* the general assertions it contains require to be dissected; and then they will be found to represent anything but the accurate state of the case. I shall have occasion to notice some of them presently. But I will come at once to what I conceive to be the main question between the Commissioners of Sewers and the Board of Health.

In a vast city like London, the greatest difficulty with which a body charged with its drainage have to grapple is its surface drainage, as contra-distinguished from its house-drainage. Now, without asserting that the Board of Health leave surface drainage wholly out of their consideration, I still venture to say, that they devote their chief attention to house-drainage; and not unnaturally, seeing that they have to deal mostly with small provincial towns, where surface-drainage does not hold the same relative importance as in and about London.

In a small country town, not already provided with surface drains, you may often, with comparative safety, allow the rain to a great extent to flow over the surface of the streets, or along the open side channels, till it reaches the nearest ditch or brook, especially where, as is frequently the case, there are no basements to the houses. In London, the *whole* of the surface drainage is, or ought to be, carried to its ultimate destination in covered channels under ground, which must be deep on account of the basements, and for other reasons. To show approximately the relative quantities of house and of surface drainage which ought to be provided for, I must trouble your Lordship with a few figures. The quantity of house sewage in London may be estimated by the quantity of water supplied to the houses. This should be, though in point of fact it is not nearly so much, at the rate of 5 cubic feet, or about 31 gallons, per head per diem, so that, looking forward to a considerable increase of population, *i. e.* allowing for a prospective population of 3,000,000, and an adequate water supply, provision should be made for 15,000,000 of cubic feet per diem; but as the flow of house sewage during about six hours of every day is double its general average, the provision of house drainage sewers should be equivalent to an equable daily discharge of 30,000,000 of cubic feet.

The amount of surface drainage is measured by the quantity of rain which falls. Whatever may be the case in small country towns, in London it will not answer to provide sewers for merely ordinary rain-falls, not exceeding at any time a-quarter of an inch per diem: provision at the rate of two and a-half inches per diem must be made for storms. This rate will give for the entire metropolitan area of 114 square miles, under the jurisdiction of the Commissioners, 662,000,000 of cubic feet per diem, the quantity for which surface drainage sewers ought to be provided.

The requirement, then, for house sewage is to that for surface water as 30,000,000 to 662,000,000, or as 1 to 22; whilst the Board of Health pay great attention, and very properly, to 1 part in 23, they appear to under-estimate the importance of making due provision for the 22 other parts.

The mode of conveying this entire mass of sewage, amounting to 692,000,000 of cubic feet, into the Thames, its present receptacle, claims consideration in the next place. Every road which has houses on each side of it, would require, according to the Board of Health system, three sewers at least, one running under the road to receive its surface drainage, and also to serve as an outfall of the entire drainage of all sorts of the districts higher up, and two other sewers, one on each side, behind the houses.

* See *Journal, ante* pp. 126, 177.

See *Journal ante* p. 125.

These two latter sewers receive from behind, the drainage of the individual houses, and also, I assume, the rain which falls in their rear; they are of pipes commencing with the size of 6-inch diameter, and gradually enlarging to 9-inch and 12-inch, &c., according to the length they run; but I presume they would not be allowed to run for any great continuous length; at each convenient opening, I take for granted, they would be brought round from the right or the left, and connected with the central sewer under the road. This central sewer, before it has traversed any considerable length of the five miles between the water-shed on the margin of the basin of the Thames and that river, would receive such accessions of sewage and water from the above mentioned sewers on each side, as well as from the road itself, that it would soon greatly exceed, in magnitude and importance, the side house sewers; of course its size would vary considerably, being small near the water-shed line and large at its outlet into the Thames; but its mean capacity, or rather discharging power, would require to be about sixty times that of each of the pipe house sewers behind the houses. Its size, at no very great distance from the water-shed line, must exceed the capability of pipes, and, consequently, it must thenceforward be made of brick, and it is necessarily placed under the road, where expense of every kind attends its construction; it therefore constitutes not only the most important, but the most costly part of the entire system of sewerage.

In spite of all the considerations here pointed out, the advocates of the Board of Health system either entirely overlook or make light of this most important sewer. It may, perhaps, be overlooked or made light of in small country towns, in London it must not.

I have spoken of its relative capacity in comparison with the rear sewers; its average absolute capacity, I am not in a position to state; that must depend chiefly on the breadth of the area which it drains. Assuming, for the moment, that all the London sewers could at all times be rendered "self-cleansing" and self-repairing, so as to render it unnecessary for men ever to enter them, then the question of size becomes simply an hydraulic question.

Viewing the existing sewers merely in this aspect, it would appear that, until lately, in determining their sizes, hydraulic science had been exercised either not at all, or very scantily. Some of them are, beyond a question, unnecessarily large; still more of them are too small; the consequence of which latter defect is, that basements are flooded, and property destroyed, to a very large amount annually. Some of such sewers, therefore, where they cannot be relieved, will have to be re-constructed of a larger size. In most cases, however, this necessity will be avoided by the construction of the Great Intercepting Sewers, recently designed by the Engineers of the Commission, which, by dividing the present drainage area on each side of the river into separate zones, will in effect create so many distinct and parallel water-shed lines, in lieu of the present single line, and will on those lines intercept the existing sewers, relieving the lower parts of them which are now gorged by the excessive quantity of sewage flowing from the higher parts. In an economical point of view, this collateral benefit ought not to be overlooked, in considering the advantages to be derived from the expenditure of the 3,000,000*l.* which the main drainage works will cost.

Of late, in laying down new sewers, hydraulic science has been rigorously applied, with a view to prevent either a defect or an excess in their size. And here, my Lord, I feel bound to observe, that the Commissioners have not accepted the hydraulic tables which are understood to be adopted by the Board of Health, those tables being in a large measure at variance with the results both of science and experience, English as well as Continental, and being such as, if adopted for London, would entail the most serious consequences to the health and property of its inhabitants, by giving rise to the construction of sewers too small to answer the purposes intended.

But there is an ulterior consideration which has compelled or induced the Commissioners, in a very large number of instances, indeed generally, to make the sewers larger than purely hydraulic considerations would require; and that is the necessity or advantage of enabling a man to enter them, for the purpose of cleansing or repairing both them and the house drains. The Board of Health questions, I believe without any qualification, this necessity and advantage. The necessity must be patent in one large class of cases, namely, where the sewers, of whatever construction or material, must *inevitably*, from their position, become more or less "Sewers of Deposit." This happens with reference to the lower parts of all, or very nearly all, the sewers of London, the mouths of which are now closed for about eight hours of every tide, or about two-thirds of the entire day. The depths at which they must be kept enable them to discharge into the river only at low water; the rest of the time they are closed up, and therefore stagnant for a considerable length from the river. During the periods of stagnation, deposits unavoidably form and accumulate, which can only be removed by manual labour: flushing would not effect it. Now the accumulation of deposit, under such circumstances, has nothing whatever to do with the size or material of the sewers; it would equally take place with pipe sewers of the very best material and workmanship. I must, therefore, beg leave at once to dispose of the largest proportion of Mr. Ward's comparison, wherein, as if with a tacit reference to an imaginary similarity of circumstances, he characterises pipe sewers as "self-cleansing," whilst he asserts that "the big street sewer is nine times in ten an elongated cesspool." A second deduction must be made from his comparison in respect of sewers of antiquated form, constructed many years or even generations ago, and condemned universally by the present generation; such sewers are never made now. A third deduction must be made in respect of those sewers which are subjected to unfavourable circumstances, equally, or in a greater degree, producing stoppages and deposit in pipe sewers themselves, such as bad workmanship, a bad fall, or a deficiency of water,—misfortunes which are always pleaded as excusing a stoppage in a pipe sewer. There remain only those sewers which are of proper form, well built, with a fair fall, and sufficiently supplied with water; such sewers rarely accumulate deposit, more rarely than pipe sewers under similar circumstances. I say this advisedly, as being the result of large London experience. When deposit does form in the large brick sewer (and this will now and then happen, not only in brick, but also in pipe sewers), the means are at hand of entering it, and removing the obstruction, without the necessity of breaking up the street,—a highly inconvenient as well as costly expedient in London.

There are cogent grounds for believing that a much larger proportion of the London sewers than the Board of Health appear to suppose, would be found not one whit larger than simple hydraulic considerations imperatively demand.

It is only for the remainder that any apology is needed; for those near the river, the justification of their size rests upon the absolute *necessity* I have before pointed out of men being enabled to enter and cleanse them; for those higher up, a good reason is offered in the general principle advocated by engineers —that inasmuch as every machine, however perfect, is liable to occasional derangement, each part of it ought, if possible, to be rendered easily accessible for the purpose of repair or adjustment. For a description of the construction of the ordinary modern brick sewer, and of the several purposes for which it is adapted, I beg leave to refer your Lordship to Mr. Bazalgette's Report on Rugby, &c. Against the alleged superior efficiency of pipe sewers, I have to urge the contrary experience of the Commissioners and their officers. But I venture to submit, that the simple consideration of the form of the ordinary sized brick sewer will almost serve to demonstrate its equal, if not superior efficiency. At its lower part, it is neither more nor less than an 18-inch barrel, the upper part merely of the circle being removed and its place supplied by a larger and higher structure. So long as the sewage does not rise higher than the lower part of the circle which is left, the channel is practically the same as in an 18-inch pipe, the same degree of smoothness being soon attained, as shown in Mr. Bazalgette's Report. When the sewage rises higher, the advantage is decidedly in favour of the brick sewer, as the upper frictional surface is partly removed and partly thrown outwards, thereby increasing the hydraulic depth.

I have dwelt thus long on the central sewers under the roads and streets, because it is upon them that the main controversy between the Board of Health and the Commissioners of Sewers really turns. I have endeavoured to show your Lordship that, even assuming the system of combined back drainage to be universally adopted in London, these central street sewers are necessary; that, in all roads and streets running towards the Thames, they must, on the average, be of large size, and therefore of brick; and that, in those districts at least which border on the Thames, including a large proportion of London, it is absolutely indispensable, and that elsewhere it is convenient, that they be of a capacity sufficient for a man to enter. That the advocates of the exclusive use of small pipe sewers are unconscious of the true importance of the large sewers I speak of, may be attributable to the more narrow and partial views naturally attendant on mere provincial experience.

If the preceding statements be well founded, the question of combined back drainage assumes a very subordinate place in the controversy. In truth, it is not an engineering question: it is a question of mere detail, concerning the mode in which the house drainage should be arranged. The Commissioners have no objection to back drainage abstractedly: their substantial objection is to the dangerous and disastrous notion of attempting to substitute it for the important street sewers already described. They permit it in many cases. Applications for leave to adopt it are made almost daily, and the engineer has very seldom been obliged to refuse permission for its adoption. But, in truth, the system is not a favourite one with the more respectable London builders, who prefer a separate drain for each house, running under the latter, and then half way under the street, into the sewer in front, just in the manner described and so strongly censured by Mr. Ward. Even in towns drained under the auspices of the Board of Health it is not always adopted. If your Lordship refers to Mr. Bazalgette's Report, you will find that at Rugby and Sandgate it has been generally repudiated. In the metropolitan districts, the cases where it is most strongly contended for are where speculative builders of an inferior grade run up blocks of small houses in the cheapest and slightest manner that the law will permit, with a view to get them off their hands as soon as they can. Such persons, of course, struggle hard for the cheapest system which can pretend to the name of drainage, without much regard to its permanent efficiency.

Mr. Ward cites Lambeth-square as an instance where combined back drainage has been beneficially and successfully adopted. It is proper to observe, that the mode of drainage is, in some respects, not accurately described; but such as it is, I beg to state, that Mr. Bazalgette considers this to be one of those cases in which he would now recommend that system in preference to separate front drainage. Again, Mr. Ward alleges the expense to have been one eighth of the cost of separate drainage. A calculation has been made of what each system would now cost; the cost of the combined mode would be to the cost of the separate mode as 1 to about $1\frac{1}{4}$, instead of 1 to 8. It will not be difficult to show your Lordship that a like misapprehension commonly prevails as to the relative expense generally of the two systems.

The remarks I have already offered with reference to the central or street sewers, must tend to show that such sewers essentially form the basis of both systems, and that the size of those sewers does not depend upon the adoption of either system. We may, therefore, leave them out of the comparison, and contrast only those subordinate sewers and drains which are peculiar to each system.

The separate system then has, at all events, the advantage of simplicity. It consists of a single house drain running from the back of and under each house, across half the street, to the sewer in front; the length of the drain being about equal to the depth of the house and half the breadth of the street.

The combined system, wherever there is a basement to the house, which is ordinarily the case in London, embraces three lengths of pipe; 1, that portion of the pipe sewer at the rear which corresponds with the extent of the house in front; 2, a short branch pipe from the rear of the house to that sewer; 3, *a pipe branch from the front of the house, half-way across the street, to the sewer in front, for the drainage of the front area.* This last mentioned drain is sometimes given in the statements and diagrams of the Board of Health, and sometimes omitted. I must crave leave to insist on its being included as a general rule, where London is in question, because there the houses generally have front areas, and the kitchens must not be exposed to flooding for want of a drain in front. It is true that occasionally, perhaps generally, the Board of Health, instead of separate front area drains for each house, substitute a single line of pipe sewer running along and parallel to the whole length of the houses, and like the sewers in the rear, joining the central sewer at a certain interval. This, however, will make no material difference in the cost; the only difference will be some diminution or increase of the length of pipe attributable to each house; according as the street happens to be broad or narrow, as compared with the front of each house. In this case, the area drains are dispensed with, and their place is supplied by two additional sewers, making five in all, viz:—two pipe sewers at the rear of the houses, two others in front, and one large central sewer under the middle of the street.

Now, comparing the relative cost of these two systems, omitting the common central sewer, and estimating the cost of each by the length of pipes required, it will readily be seen that the breadth of the street, the length and the breadth of each house, as compared with each other, must decide the question. In some cases these elements will give the result in favour of one system, sometimes in favour of the other.

I trust I have now said enough to make it appear at least probable that the alleged great superiority, in point of cheapness, of the system of combined back drainage is a mere illusion, arising chiefly from inattention to the indispensable necessity, under any system, for large street sewers; and partly, but in a less degree, from an occasional forgetfulness of the necessity of draining front areas; and in some degree, also, from an unfair comparison of country with London prices, and an oblivion of the costly precautions, repairs, &c. peculiar to the streets of London. Of course I must be understood as speaking only of London drainage: with the drainage of country towns I have no concern.

In considering the relative efficiency of the two systems, it must be borne in mind that, after all, the question turns upon a comparison merely of one set of pipes with another set of pipes; and that the street sewers are not involved in it. Indeed, it may be affirmed, that combined drainage must be attended with more hazard, because the sewage, from the time it leaves the house at the rear till it reaches the main sewer in front, traverses a longer and more circuitous route than that which is traversed in the house-drains under the separate system. A well-constructed single house-drain has been found in practice to be unattended with the nuisance or inconvenience alleged in Mr. Ward's letter; obstructions seldom occur in such a drain, if of sufficient capacity; and when they do take place, they are readily and inexpensively removed from within the street sewer, without tearing up the street or the kitchen floor.

Were the system of combined back drainage to be generally adopted in the denser parts of London, it would frequently become inevitable to pass under some one house the pipe forming the common outlet of the entire block. In addition to the inconveniences enumerated in the same letter, and which are practically found much more serious than the writer represents, the system confers upon the occupant of one house the dangerous and often abused power of cutting off or otherwise prejudicially interfering with the drainage of his neighbours; and the Commissioners experience considerable difficulty in dealing with such cases in the present state of the law, which does not contemplate combined drainage works.

Neither can the Commissioners acquiesce in the expediency of using pipes of so wide a range, in point of size, as that indicated in the same letter. It is found that the 4-inch pipe stops, and the 20-inch pipe breaks. The Commissioners have come to the conclusion that it is not expedient to use pipes smaller than 6 or larger than 12 inches in diameter.

There are, doubtless, many instances in which combined back drainage is for particular reasons admissible; but it is impossible to classify them under general heads for practical application. The Commissioners, some time ago, finding great diversity of practice upon this, as upon other points, prevailing amongst the surveyors who had charge of the several districts, and thinking it desirable to introduce something like uniformity, laid down certain *general* rules for the ordinary guidance of their officers, whose discretion they wished to restrain within prescribed limits. But they never intended thereby to tie their own hands, their object being to reserve the exceptional cases for their own immediate judgment, or that of the superior officers of the Commission. The result of their experience is, that, in the great majority of instances, separate drainage is the best system for London, especially in the denser parts. In the suburbs principally, but occasionally even in the centre of the town, exceptions are liberally permitted.

The restriction placed by the Commissioners upon the use of pipes for small sewers, except in certain favourable situations, has been based not upon any objection to pipes abstractedly, but upon their proved insufficiency in point of strength. The manufacture of them, however, has, within the last twelve months,

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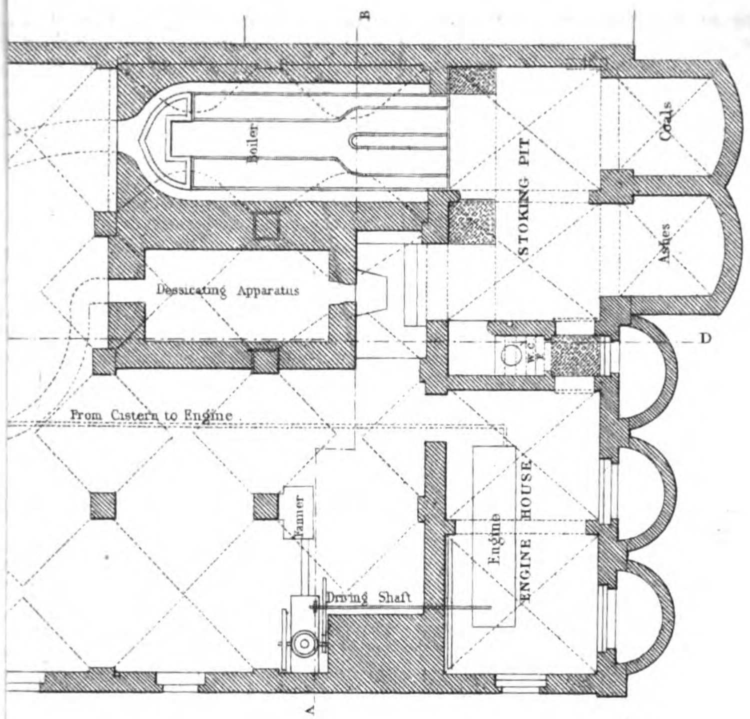
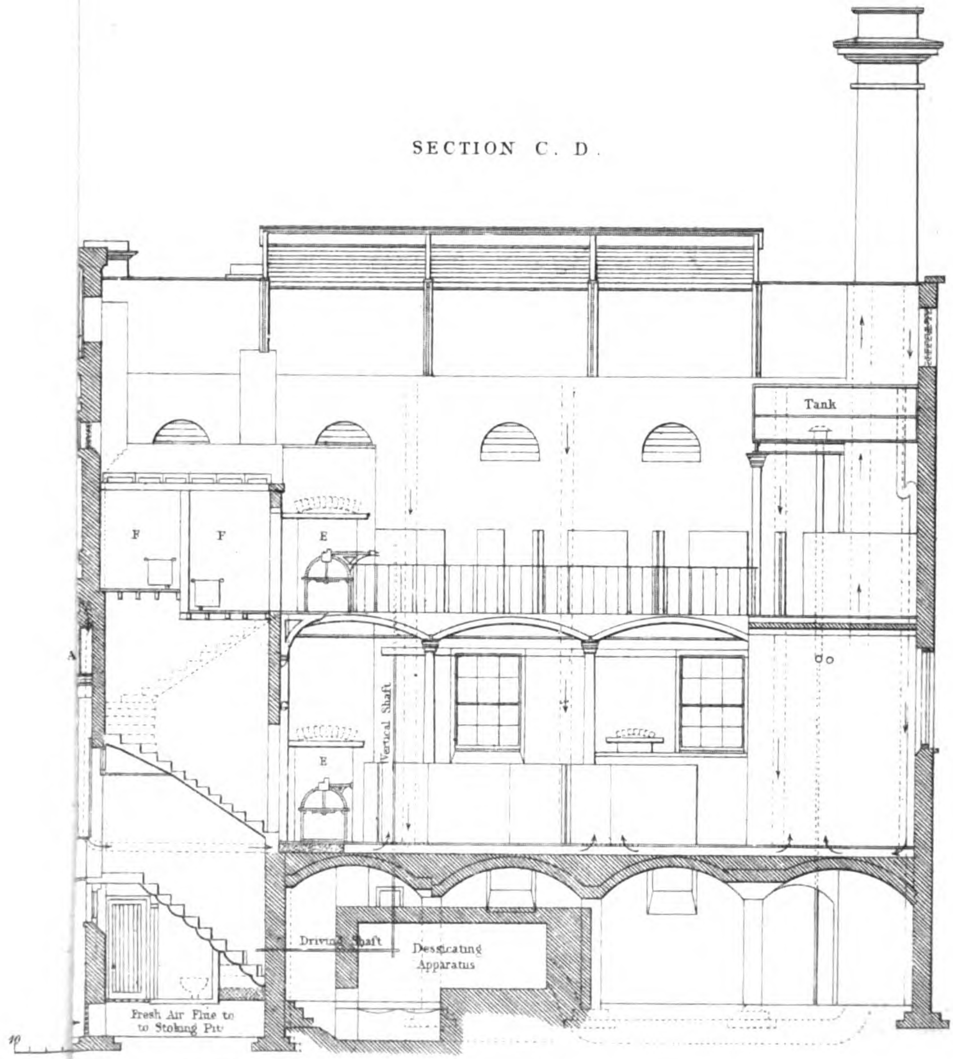



SECTION C. D.



been materially improved, owing to the regulations of the Commissioners themselves. A year ago the best pipes procurable were generally too thin to be safely used under roads: they are now better, the Commissioners, after much and pertinacious opposition, having succeeded in inducing the manufacturers to make them of good material, and well burnt, 1¼ inch thick; and the Lambeth manufacturers are now preparing to make them still thicker. When this is accomplished, it may fairly be anticipated that the use of them may be safely extended to situations where the Commissioners have been hitherto under the necessity of constructing small half-brick barrel sewers. The justification for the restrictions hitherto established in the use of pipes is to be found in a large body of well authenticated facts. These are derived from various sources, and amongst others, from Mr. Bazalgette's Report on the failure of pipes in the Metropolis, referred to by Mr. Ward,—the accuracy of which has been most unjustly impugned, both in his letter, and in a blue book of last session, No. 1009, being the further Report of Mr. Austin, on the Croydon Drainage, laid before your Lordship.

Any remaining topics touched upon by Mr. Ward are purely matters of detail. He seems to lay much stress on the use, for house drains, of 4-inch pipes (the size which the Board of Health prescribe), on account of their having a more concentrated flow, and therefore a greater scouring power. The Commissioners prefer 6-inch pipes, because, whilst the difference of cost is very trifling, and whilst the loss of scouring power is practically insignificant, the 6-inch pipes allow more readily of the passage of those innumerable substances which are so often "improperly admitted," and which will continue to be improperly admitted by careless or mischievous persons in spite of better knowledge. The experience of the Commissioners has satisfied them that where pipes of the smaller diameter are used, stoppages more frequently occur requiring the taking up and reconstruction of the house-drains at a serious cost. Three or four years ago, the use of 4-inch pipes was largely enforced in the Metropolis by the then Commissioners, often against the urgent remonstrances of the house owners. In many instances those pipes have failed: in some instances, after a first failure, they have been reconstructed and have failed a second time, and have ultimately been replaced by 6-inch pipes. It may, perhaps, be alleged that the failures were owing to bad workmanship; no reason appears for attributing them to such a cause; which, if it did apply, would apply equally to, and produce a like result in the case of 6-inch pipes, which is not found to be the case.

Much more might be urged in support of the regulations of this Commission; but it has been thought better to draw your Lordship's attention to the more prominent features of the subject, and not to enter into more minute detail than was absolutely indispensable for forming an accurate estimate of the relative value of the systems under discussion.

1, *Greek-street, Soho, March* 8, 1854. RICHARD JEBB.

## NEW WASH-HOUSE, FREDERICK-STREET, LIVERPOOL.

(*With Engravings, Plate* XXV.)

THE general arrangement of the wash-house is as follows:—A, is the pay-office, with a window and pay-table to the entrance lobby. On entering, the washer receives a ticket from the clerk, stating the number of the washing compartment to be occupied and the time of taking possession. The compartment is pointed out by the superintendent of the wash-house. When the washer has finished her work, she hands the ticket to the superintendent, who writes on it the hour at which she leaves, and the length of time that the compartment has been occupied. The washer, in going out, hands the ticket to the clerk at the office, who calculates the amount which she has to pay, and receives the money. The pay-office has another window, looking into the wash-house, which, with the pay-window and half-glazed door, affords the means of supervision of the whole establishment. A clock, with one dial to the pay-office, and another to the wash-house, is placed in the wall over this window. The washing compartments on the ground-floor are arranged as shown in the plan. There are three passages or avenues, one in the centre and one on each side, with washing-stalls right and left; this forms the second-class portion of the establishment. Three compartments are partitioned off from the others by a half-brick wall, and have a separate entrance. These form a separate wash-house B, for infected clothes during the prevalence of disease, and have connected with them a drying-closet C. For the general purposes of the wash-house, drying-rooms D, D, are provided. They are fitted up with wooden clothes-horses travelling on rails laid in the floor. E, E, are Manlove and Alliot's patent hydro-extractors, by means of which hand-wringing, with its injurious effects on clothes, is entirely obviated.

The washing compartments in the gallery floor, which constitute the first-class portion of the establishment, are arranged round the walls. The central area is entirely open, and lighted from the roof; and a projecting gallery of Yorkshire stone, carried on cast-iron brackets, forms the communication between the two side galleries. At the further end of the building, supported by a continuation of the iron columns of the gallery, is a tank of boiler-plate, capable of containg 7000 gallons of water.

Each washing compartment contains a square washing-tub and a circular steaming or boiling tub, each supplied with cold water and steam *ad libitum*; a brass plug in the bottom of each tub conveys the waste water to the drains. In addition to these tubs, some of the compartments around the walls have a dolly-tub, a favourite system of washing in this part of the country.

F, are waterclosets fitted with Kirkwood's common closets. The working machinery of the establishment is contained chiefly on the sunk floor, over which the whole area of the building within the external walls is carried by a system of groined arches on brick pillars 18 inches square. The unconfined and uninterrupted working of the whole apparatus is thus obtained, with a ready means of access to the drains and water and steam-pipes without disturbing the arrangements or marring the cleanliness and order overhead. The steam-boiler is one of Galloway's patent. Adjoining the boiler is Davidson and Co.'s patent desiccating apparatus. The hot air from this ascends to the drying-rooms by the flue G, with a branch flue to the drying-closet C, of the infected clothes wash-house. The machinery is driven by a horizontal engine of 5-horse power. The fly-wheel shaft, passing through the wall of the engine-house, communicates its motion to the fan of the desiccating apparatus, and to a vertical driving-shaft running through both floors to the hydro-extractors E, E; and in a very small space high velocities are obtained by the use of Parker's system of banding-pulleys. The pipes for the supply of water and steam to the building are shown lined on the section and dotted on the plan of the gallery floor. They are hung to the cast-iron beams with wrought-iron slings, securing free action for the pipes in expanding and contracting. Vertical branches from these pipes lead to the compartments on both floors. Ventilation is provided for by main ventilating flues under the passages on the ground-floor, with gratings at regular intervals in the floor, to which fresh air is conducted by flues descending the walls round the building and under the floor from the street front. To prevent water lodging in the main flues, each has a communication with the drains. A flue is likewise carried from the areas of the cellar windows through the engine-room to the front of the boilers, securing a moderate temperature even in front of the fires. A pipe from this flue communicates with a cavity all round the brick pillar, imbedded between the boiler and the furnace, where, from the strong heat from these two fires, it would otherwise be liable to be destroyed, and endanger the stability of the arching overhead. Flues from the ceiling of the engine-room and from the front of the furnace lead along the spandrils of the arches to the external air. Near the roof and along the front and one side of the building are semicircular openings, and in the back wall is a circular opening, all fitted with galvanised iron louvres.

The building is of brickwork, with red freestone dressings in front; the steps and landings of Yorkshire stone. The roof is of galvanised iron, segmental in form. It is glazed on each side of the centre for nearly its whole length; the vertical spaces between the roof and the glass are filled in with galvanised iron louvres, made to open and shut by cords from the gallery. The whole of the fittings, the roof, and a large portion of the building materials were obtained in taking down wash-houses previously erected in connection with Cornwallis-street Baths, in the immediate neighbourhood, their site being required for extension of these baths now in progress.

The whole of the works are from the designs and under the direction of Mr. Newlands, Borough Engineer; Mr. Pennycook acting as draughtsman and clerk of the works. Mr. Tomkinson is the sole contractor.

## SLIDING CAISSON AT KEYHAM DOCKS.

By Samuel Clegg, jun.

[*Lecture delivered at the United Service Institution, June 14th*, 1854.]

I have much pleasure in answering a request that has been made to me by your Council, that I should give a lecture upon "Caisson Gates for Docks." I will to the best of my ability illustrate the subject, and trust that I shall be able to give the desired information.

Caisson Gates for Docks is a subject of great interest to engineers, and to those connected in any manner with shipping and commerce. To engineers, because their construction and arrangement involves principles which have only of late years been practically applied to such purposes, and his best energies are in consequence enlisted;—to sailors and dock-officials, because the safety they already ensure, and the prospect they hold out of increased facilities for docking and undocking vessels, permit them to look for still greater improvements and advantages, not only in the docks themselves, but in the magnitude of the ships they are destined to accomodate.

All machinery and contrivances connected with docks are of positively recent origin. The changes that have taken place for the better, since the commencement of this century, are enormous. London had then no docks,—may not we ask what could our trade have then been, that it could put up with the difficulties and delays which must have attended the loading and unloading of ships in mid-river, and the still greater obstacles such a want must have thrown in the way when repairs had to be done? London, I say, at the commencement of this century, had no docks, unless we except one at Blackwall, and the Greenland Dock, built by Mr. Perry and Mr. Wells respectively, both private shipbuilders. Does not this seem incredible?—that this city, unquestionably the first in the world for its opulence, its commerce, and public spirit, and possessing within itself the powerful internal means of supporting docks, and all other conveniences that trade and shipping might require on the most extensive plans, has been the last to try the experiment of docks. Notwithstanding the total inadequacy of legal quays, which subjected the merchants to incalculable losses and delays, and in many cases proved absolutely ruinous; notwithstanding the effect of the heavy, expensive, and fatal embarrassments experienced regularly on the arrival of the West India fleets, and the annual losses by plunder in the river, it was not until the year 1799 that prejudices and private interests were so far removed, as to enable the merchants concerned in the West India trade to obtain an Act of Parliament to carry into execution a plan of docks, quays, and warehouses, on the Isle of Dogs, for the convenience of that trade.

The Docks of Liverpool were the first of the kind that were constructed in this kingdom, by virtue of an Act of Parliament passed in 1708. From that period the town of Liverpool has rapidly raised itself from a poor fishing village and a port for coasting vessels, to be the second commercial town and port in the empire; and the improvements lately carried into execution, of enlargement and better arrangement of the docks, will, when thoroughly developed, render it for convenience in this respect the *very* first, London not excepted.

Docks have assisted materially to develope our national commerce. Its constant increase and the attendant requirements have rendered it expedient to increase the size of our ships; therefore our docks and dock entrances are now far larger than they were a very few years ago. Not only, however, have our merchant ships been enlarged both in length and beam, but our war-ships also; and as the dock entrances and gates which have to admit these monsters are from their size the most interesting at present, and since the caisson gate I shall have presently to describe has been designed for a royal dockyard, I shall confine myself to that which relates to them.

It was at one period thought (and that time not years ago) that our dock entrances would have to be widened to admit the paddle steamers, which were gradually being made larger and larger; but I speak with confidence when I say, that paddles will become matters of history, and only seen in museums—for the screw propeller, although even yet in its infancy, has succeded so wonderfully, that its universal adoption (at all events to sea-going vessels) may be expected with certainty. Again, it is true that steamers may be built of such magnitude as to require paddles as well as a screw to move them—such a one is now being built. We must wait the result; and if, in addition to the enormous beam of the vessel itself, paddle-boxes *must* be added—why, our dock authorities must expect greater demands for accommodation than has even yet (except, I believe, at Birkenhead) been provided, or even contemplated.

To make my remarks more intelligible to those of my hearers who may not be perfectly conversant with such matters, I will explain the different kinds of docks prepared for the reception of shipping, so that by understanding the various forces that at different times act upon their gates, the precautions necessary to be taken in their construction may be better appreciated.

Docks, then, are of three kinds,—viz. Tidal, Wet, and Dry. With the first we have nothing to do; it is simply a space enclosed by quay walls at which ships may load and unload, with greater safety and facility than in a river or open harbour. This space is not closed by gates, and consequently the tide rises and falls within it, to the same extent as it does without: such docks can therefore only be made in situations where at low springs the water may be deep enough to float the vessels frequenting them. Such docks are commonly termed "tidal basins," and with them both wet and dry docks often communicate.

If, at ebb tide, a "foreshore" is left between the low-water line and the place conveniently situated for docks, and it be essential that the vessels therein be kept afloat, the water which has flowed into them during flood tide must be retained by means of gates, singly or in pairs as the case may require. If there is sufficient depth at other times of the tide than at high water, double gates are erected, so as to form a lock, as on a canal. All the docks on the Thames are provided with such locks; indeed, the single gate is seldom available, except in cases such as the following. Suppose a tidal dock, and that it was necessary to provide accommodation for vessels of extraordinary draft of water, only capable of being taken into dock at high-water: a second dock would then be required to be made beyond the tidal basin, divided from it by single gates or a caisson. These gates would retain the water in the inner dock at the high-level. Thus larger vessels would remain afloat, and the general trade of the outer dock be uninterfered with.

The strength of gates for the kind of service I have been describing, when in sheltered situations, will simply have to be proportioned to the pressure of water due to the difference of level between high and low springs, extra solidity not being necessary to resist extraordinary shocks from sea waves. But when they are exposed to this force, which is often of considerable magnitude, their dimensions must be increased. The first is easily arrived at by direct calculation; the latter can be determined only from the results of practice, for no systematic or intelligible attempt has been made practically to measure the force of the waves, so as to furnish the engineer with a *constant* to guide him in his attempts to oppose the inroads of the ocean. The only experiments, indeed, on the subject, are those of Mr. Thomas Stevenson, who had long entertained the idea of registering the force of the impulse of waves, and lately contrived an instrument for the purpose which he has applied at various parts of the coast. The results he detailed in the Transactions of the Royal Society of Edinburgh, of 20th January 1845.

It would naturally be expected that the force of the waves should vary according to the season of the year, and the nature of the exposure; and this expectation is fully justified by the indications of the marine dynamometer. Thus it appears, that during five summer months of 1843 and 1844, the average indications registered at different places near Tyree and Skerryvore, gave 611 lb. of pressure per square foot of surface exposed to the waves; while the *average* for the winter months for the same places during those two years, gave 2086 lb. per square foot, or upwards of *three times* that of the summer months. It also appears that the *greatest* result as yet obtained is 6000 lb. per square foot; but these experiments have not been continued long enough, nor as yet applied to a sufficient variety of places, to render them available for the engineer. In the present state of our information, therefore, we cannot be said to possess the elements of exact investigation, and must consequently be guided chiefly by the results of those numerous cases which observation collects, and which reason arranges in the form which constitutes professional experience.

In determining the dimensions for strength, we must not in any case venture to approach very near the limit of stability, so long as we continue to labour under our present disadvantages of defective information on some of the most important elements in the inquiry. "A little stronger than strong enough," is an engineering maxim very applicable to works having to resist the impact of waves. To give some idea of the enormous force of the sea, I may mention that a mass of rock 5 feet thick and about 40 feet long, weighing nearly 300 tons, was, at Fetlar in Zetland, lifted over a point of land, into the sea at the other side: but it must be remarked, that the form of this block rendered it very susceptible of a sliding motion, and must have greatly aided its transport. The effects produced upon the Plymouth breakwater may, therefore, be considered quite as remarkable; for although the weight of a stone might not have exceeded 10 tons, the comparatively small surface compared to their weight which they presented to the sea, would be greatly in favour of their stability. We are told, that during the storm of November 1824, a length of 796 yards of finished work of this breakwater was completely overturned, and the remaining parts slightly injured. The seaward slope, which was constructed so as to be 3 feet horizontal to 1 in perpendicular height, was altered by this storm to 5 to 1, which slope it was determined to adopt. Again, in 1838, large quantities of stones of 15 or 20 tons weight each, were torn from below low-water, and carried completely over the top of the breakwater. Instances have also been given of vessels being driven high and dry upon the beach, far beyond high-water line; and I have had pointed out to me the spot upon the Chesil beach, some 200 yards wide and 12 yards high, where a vessel was driven from the sea outside into the harbour within.

In the determination of the necessary strength for dock gates, we must also not lose sight of the concussions they are liable to, from portion of wreck being driven against them, and from the vessels themselves which enter the docks.

I find I have been carried away from my subject, and will now describe *Dry* or *Graving Docks*, upon which I shall only detain you a very short time. This kind of dock is especially designed for the purpose of repairing the bottoms of ships; and they either become dry by the ebbing of the tide, when the gates are left open, or by shutting the gates at low-water, and pumping out whatever water may remain in it at that time. Before graving docks were contrived, any defect below the light line of flotation had to be got at by careening the ship over; and if this defect happened to be near the line of the keel, the force required to be exerted to heave the vessel down "keel out" was so great as to strain its framing seriously. There was danger, too, in this process, as I believe the *Royal George* was lost at Spithead while undergoing this operation: and I am sure, naval men must have rejoiced exceedingly when this barbarous system was abolished.

In *Wet Docks*, the water is required to be kept *in*; the sills of the gates therefore are made to point inwards. But graving or dry docks, the water having to be kept *out*, have their gates pointing *outwards*. When caissons are employed, the same form serves of course for both varieties. In order to save the time and expense of pumping (there being no tide), the graving-docks at Sebastopol are situated considerably above the level of the water in the Black Sea. The ships are raised into a general dock-basin by a series of three locks, each having a rise of 10 feet, the height of water in the basin being 30 feet above the level of the sea. The water for supplying the basin, for filling the docks, and for working the locks, is brought a distance of twelve miles by a canal from a mountain stream, which has a sufficient elevation for the purpose. A vessel can thus be taken into either of the docks, after it has been elevated by means of the three locks into the general basin.

This arrangement offers great facility for repairing ships, for after the dock-gates are closed, a valve can be opened, and the water be let out very quickly into the sea through a subterranean culvert, leaving the ship high and dry. I trust that Admiral Dundas will do as little damage as may be to these docks, for we shall find them very convenient for executing repairs, the largest of them being capable of receiving a ship of 120 guns.

The gates were originally intended to have been constructed of timber, but owing to its naturally rapid decay, coupled with the apprehension of the destructive ravages of the "teredo navalis," it was deemed expedient to construct them of metal, as they could be made to perform their duty better, from their greater accuracy of workmanship and their increased durability, which in the end would more than repay the first outlay. These excellent gates were made entirely by machinery. The gross weight of metal in the nine pairs of gates was 1760 tons, and 72 tons of metal were taken from them by planing and drilling.

The gates of graving-docks, presuming the same rise of tide, must be stronger than those for wet docks, having a certain depth at low water, because they have to sustain the entire pressure of the water on one side only, and have not the lower portion up to low-water mark in equilibrium. The method of ascertaining the amount of pressure caused simply by the water on the entire surface, or upon any one point in the surface of dock-gates, is extremely simple. A non-elastic fluid, like water, presses equally in all directions. Its pressure downwards is equal to its gravity multiplied by its perpendicular height. Its pressure upwards is best exemplified by its efforts to float vessels, the line of flotation being determined by the difference between the gravity of the material of the floating substance (supposing it solid) and the water. Or, to speak by the book, a body immersed either wholly or in part in water, and at rest, receives from the water pressures which are together equal to a vertical force directed upwards through the centre of gravity of the water displaced by the body, and equal to the weight of a quantity of water so displaced by the immersed part of the body.

This is further practically illustrated by the camel used to lift ships having great draught of water, over shoals, as at Cronstadt; also by ice, which is lighter than water, coming in contact with caissons, and lifting them out of their seats. Its pressure sideways, or its horizontal pressure, may be illustrated by taking a tube bent like the letter U, and putting a vertical diaphragm closing the bore of the tube at the lowest point, so that water, filled to a certain level in one of the limbs, be retained there; upon removing the diaphragm, the water will rise in the other limb, the surface of the water in each being on the same level; the pressure therefore against the diaphragm was that due to the column of water contained in the first limb. The total pressure against such a surface as a dock-gate is equal to a prism of water whose base and perpendicular height is equal to the depth of the water, consequently the pressure increases as the squares of the depth of the immersed gate. A gate 20 feet deep, having to sustain a pressure equal to four times that upon one 10 feet deep, each being of the same width; and to find the whole pressure in pounds, the square of the immersed depth must be multiplied by $62{\cdot}5 \div 2$, or $31{\cdot}25$ lb. Thus the total pressure upon each foot in width of a gate 20 feet deep will be $20^2 = 400 \times 31{\cdot}25$, or 12,500 lb.; on a gate 10 feet deep, 3125 lb. If the moments of all the pressures were accumulated at one point, called the centre of pressure, it would be found to be at a point equidistant between the sides of the gate, and at a depth of two-thirds from the surface of the water, that being the position where the horizontal pressure resulting from the centre of gravity of the prism of water would be accumulated. And if the gate has to be shored up, or chains attached to open it by, it is on this line they must be secured to produce the greatest effect.

To calculate the direct weight or pressure that any of the bars of the gate will have to sustain, it is simply necessary to multiply the weight of a cubic foot of water, 62·5 lb., by the width of the gate, and the product by the depth of the bar below the surface. The determination of the strengths of the various bars of a gate, then, as suggested by theory, is, to give a safe dimension for the bottom bar, and let the others gradually diminish in strength to the top, in the same ratio nearly as the diminution in the depth of the water. Or, which is the more usual practice, make the bars of the gate of the same dimensions throughout, but put them closer together at the bottom. In a large gate both may be done.

The dimensions thus obtained are those necessary to resist simple pressure merely; but, as I have before observed, gates are subject to concussions, wear and tear from abrasion (especially if of timber), and unequal strains, which nothing but experience will enable an engineer to counteract by economical dimensions; and economy is all important—indeed, the reputation of an engineer often depends upon the *commercial* success of his labours.

An inquiry of some interest is opened when an engineer has to decide upon the use of turning gates or of caissons,—they both have their advantages, and both their disadvantages. For openings up to 60 feet wide, where the water does not rise higher than perhaps 20 feet, turning-gates, I think, would be preferred to the common caisson gates, since they are always in their places, and the time required to dock or undock a ship is less than that occupied in lifting, floating away, and returning the caisson. With the *sliding* caisson, as designed by Mr. Scamp for the Keyham Dockyard, these objections do not exist; but then there must be space enough in the thickness of the wall dividing any two dock entrances to admit the caisson,—and this cannot always be.

The disadvantages of large dock-gates are—First, their original cost, which is greater than that of a caisson. Secondly, they are more frequently in need of repairs; and if the rollers at the bottom, or the step of the heel-post get damaged, their depth below water is a serious obstacle to their renewal. It is very true that all rollers are made to adjust from above, so that ordinary wear and tear is of no consequence; it is their replacement which is so difficult. The third disadvantage of large and deep turning-gates is, their liability to buckle and leak; and it is not a difficult thing to imagine that such large surfaces are sometimes pressed out of truth, and any want of parallelism between the heel and mitre posts will prevent them from meeting with that precision absolutely essential to prevent leakage. There is of necessity some leakage even through those gates exposed to the least depth of water. The leakage through equal opening increases with pressure arising from increased head; and as the difficulty of keeping gates tight also increases with their vertical and longitudinal dimensions, it follows that there must be some practical limit to the use of turning gates; and if we assume this limit to be 70 feet in opening and 25 feet in depth of water, we shall have to use a caisson-gate for openings of greater width and depth. I do not venture to say that the dimensions I have stated are *positively* the limits to the use of turning-gates—more especially if those gates be made of iron; but I *do* say that the liability of such sized gates to derangement, together with their expense, would induce me to look very favourably upon caissons.

The first instance, I believe, of a caisson being employed was for a temporary purpose as a cofferdam, during the construction of the London Docks. A collier was cut down, and a second bow substituted for the stern, to enable it to fit more closely to the aperture it had to close. I do not know the exact particulars of the case, nor do I know that I am correct in stating that it was from this application of a floating vessel for a gate that General Sir S. Bentham took his idea of using such vessels for the closing of dock entrances. I am perhaps not doing the gallant General justice; certain it is, however, that the first caisson-gate in this country was employed at Portsmouth Dockyard at the suggestion of that officer.

The transverse section of dock entrances may be said to approximate to that of the largest class vessels which they are destined to admit. The side walls are built to a curved batten, and are connected together at the bottom by an invert of masonry; this arrangement being adopted to preserve the form of the work perfect, and prevent unequal settlement. Of course, where turning gates are used, square recesses have to be provided for them to fall into, so as to leave the entire opening of the entrance available. This provision necessitates a departure from the perfect form of wall and invert, which, on bad foundations, may be mentioned as a defect—a minor one, it is true, but still a defect, since extra material must be used to gain equal strength at every part. The keel of the caisson is made to fit the curve of the walls and invert accurately, and upon this keel the caisson is built as a deep and narrow boat would be; indeed, a floating-gate is essentially a boat, ballasted like one, and floating like one at various draughts of water, according to its load. We will suppose a caisson launched and ballasted so as to float with stability; its proportions must be such, that with this quantity of ballast its line of flotation, at the lowest state of the tide at which it is likely to be moved, will keep the keel clear of the grooves cut to receive it. It is now brought near to its proper position, and by means of ropes or chains secured on shore, and to capstans on its deck, moved vertically over its grooves. The valves provided for the purpose at the bottom are then opened, and the water allowed to flow in, which settles it firmly in its place. The valves on the outer side are left open until the caisson has to be removed, that the tide may ebb and flow within it; because if it did not do so, as a matter of course, it would lift the gate, the line of flotation with the same weight remaining constant in the same vessel. To remove the caisson, the water on each side of it must be suffered to become of equal depth, proper sluices being generally provided in the masonry for this purpose: or pipes passing through the caisson, fitted with proper valves, may answer the same purpose; only when the dock which has to be filled is large, the time occupied by this arrangement would be inconvenient, since to pass the water very rapidly, the pipes would have to be made either very large, or their number increased, which would be more expensive than a sluice within the masonry. The water on each side of the caisson, then, being level, the valves are shut, and the water contained in it is pumped out until it floats clear of the groove, when it is towed or hauled away clear of the dock entrance, to allow of the vessel to pass in or out, as the case may be. It may perhaps be useful if I give the principal dimensions of a large iron caisson of this kind. I will take one for a 68 feet opening, and a depth of water of 28 feet, used at the New York Navy Yard.*

The plan of its deck was that of a vessel 68 feet long with a beam of 16 feet; its sheer plan corresponding with the figure of the groove in the dock entrance. The iron ribs are 2 feet apart, and are 6 inches deep by 1 inch thick at the keel, diminishing gradually until they are 3 inches by ½-inch at the rail of the upper deck. The plates forming the sides diminish from ⅝-inch to ⅜-inch thick, the bulwarks being ¼-inch thick. Near the bottom is the kentledge-deck, on which 95 tons of iron ballast is secured. The filling-pipes are four in number and 14 inches diameter, extending through the vessel; each pipe is provided with two valves, so that the water may be passed either from one side of the vessel to the other, or into it. The two pumps for discharging the water are 16 inches bore and 14 inches stroke, worked like a fire-engine. From the main deck there are connected with the pumps two pipes 3 inches diameter, to be used for washing out the caisson, and in case of a fire in the neighbourhood or on board of a ship in dock.

A lining of india-rubber, 8 inches wide and 1 inch thick, was fastened to the outer surface of the keel and stems, with countersunk screws before the caisson was launched, to prevent as far as possible the leakage of water between the vessel and the masonry of the dock. This, I understand, answered the purpose very well as long as it lasted, but it got destroyed by abrasion, and oak plank was substituted. This caisson cost in America about 18,000*l*. (at least so it is stated in General Stuart's work on the Naval Dry Docks of the United States), which seems a prodigious sum, seeing that the sliding caisson at Keyham, being 14 feet wider and 14 feet higher, cost only about 10,000*l*.

As pumping out the water from ordinary caissons to lift them takes much time and labour, Mr. Scamp has designed a floating caisson, to obviate this defect; and since the arrangement can be adopted wherever there is a supply of water distributed through the mains of a waterworks, it will perhaps rarely happen that it *cannot* be applied. The arrangement is simply this. The caisson is ballasted so as to float safely, as in the case before described. The top deck of the vessel, which is on a level with high-water springs, is made to form the bottom of a water-tank, the dimensions of which must be such as to contain the required weight of water to sink the caisson into its seat. This tank is filled from the waterworks' mains; and as the water in the tank is above the water in the docks, it can be let out through valves when the caisson is required to be floated, thus doing away with pumping; and the only remaining defect of such a gate is the necessity of turning it and floating it away clear of the dock entrance when a vessel has to be admitted. This the sliding-gate at Keyham gets rid of, and unless it has defects of its own, it may be called *practically* a perfect gate.

In order fully to understand the value of this gate, I must explain that it closes the outer end of the entrance to the south basin at Keyham, which entrance is made as a lock, 260 feet long, 80 feet wide, and 43 feet deep; and the inner extremity being provided with a caisson of the ordinary construction, the water can be pumped from between the gates, and a dry dock obtained. The sliding-gate on such an occasion has to sustain a pressure of about 1700 tons, arising from the entire depth of water at spring tides, which is about 38 feet or 39 feet. The strength of its various parts had therefore to be very carefully considered, and the nicety with which the entire structure had to be put together in order to ensure perfect unity, required excellent workmanship; and when I say that it was executed by Mr. William Fairbairn, of Manchester, I need say nothing more.

The arrangements of the caisson, which enables it, without pumping, to be drawn from across the dock entrance into the recess prepared for it in the masonry, or *vice versa* from the recess across the dock, are simply these. The whole of the bottom or hold is formed into a perfectly tight air-chamber, constituting what Mr. Fairbairn terms the *lungs* of the vessel, of such capacity as to make the vessel buoyant to the extent of 10 or 12 inches from the bottom; and being thus free from contact

* A description, with engravings of the iron floating gate at the New York Navy Yard, will be found in the *Journal* for 1852, Vol. XV., p. 321.

with the sill, it is easily floated into the recess. Above this air-chamber is what is called the tidal ballast compartment, into which the water has admission through two sluices, and permitted to ebb and flow with the tide, thus neutralising the buoyant principle of the *lungs*. The third compartment forms a tank capable of holding sixty or seventy tons of water, which, being filled from hose-pipes connected with the water-mains of the dockyard, sinks the caisson into its place.

Near the bottom, four large pipes, fitted with slide-valves, run through the vessel, and act as scouring-sluices to clear away any deposit left by the flood-tide upon the sill; and also, at low water, to create a current sufficient to carry into deep water the sand or silt which may have accumulated in front of the caisson. To aid the effect of the scour, the sill is made to slope each way from the centre. To explain the working of the caisson, I cannot do better than take Mr. Fairbairn's own description:—

"It is drawn in and out of the recess by chains attached to each end, and to small drums on the working gear. There are also two guide-ropes, which, after passing through the caisson immediately below the upper deck, are secured to the north recess by spring-hooks upon links fixed in the masonry. The ends of the guide-ropes are connected with the machinery of the hauling-chains, and are wound upon barrels in the south recess.

"In order to remove the caisson from its position (assuming the entrance to be closed), and to draw it into the chamber, the ends of the guide-ropes require to be secured to the north recess, and the two small barrels on the shaft are then employed to tighten the ropes, and being fixed by their pauls, the hauling gear is then detached from the tightening drums by sliding clutches, which operation liberates that portion of the machinery required for the purpose of drawing the caisson into the recess. Before commencing the hauling process, however, it is necessary to float the caisson (which hitherto has rested upon the bottom), and this is accomplished by opening a valve 12 inches diameter in the bottom of the upper water or ballast tank, and discharging the necessary quantity of water into the tidal compartment below. The caisson then rises gradually to a height of four or five inches from the floor, when it is ready for being drawn into the recess, a process which occupies a few men at the capstan about eight minutes.

"When shut, the whole of the caisson is supposed to be filled with water to the level of the tide, excepting only the air chamber, which, it will be observed, is the only buoyant principle it possesses for raising it to a height sufficient to float it into the recess; and the water having free access through the tidal compartment, will stand at the same level on both sides of the caisson.

"The admission of the water into the tidal ballast compartment is effected in two ways, either by opening the slide-valves, or by allowing the free working of the flap-valves on the back of the slides, which open inwards; they therefore, open and shut by the pressure of the water, as it may stand higher or lower on either side of the caisson. These flap-valves are added for safety, for if the slides were not opened at the proper time, a rising tide might affect the stability of the caisson.

"When the vessel has entered the dock, the caisson is drawn from the recess by the working gear on the opposite side of the chamber, the guide ropes being used as before. The water-tank is filled with water, and the caisson sinks quietly into its place on the sill."

When the caisson has to be removed for painting or repairs, and it becomes necessary to float it away, the tidal and water chambers must be emptied at low-water, the flap-valves secured from opening, and a valve opened to admit water into the air-chamber, which then becomes for the time the ballast chamber, containing about 300 tons. The only peculiarity requiring further to be explained is this. Supposing the caisson to be ballasted at 2 inches above the floor at low-water; at *high*-water it will, of course, have a buoyancy equal to the displacement of the materials of which it is constructed, for the space of the rise of the tide, which is equal to about 15 tons. If ballasted at high-water, it will sink on the floor at low-water with an equal weight. To counteract this, ballast-trucks are provided in the chamber at each end, and level with the deck, and these are brought out as may be required to suit the depth of water the caisson is required to work in.

As it may be interesting to know some of the principal dimensions of the iron of which this excellent piece of work was made, I will in few words give them. As I have before casually mentioned, the length of the caisson at the top is 82 ft. 6 in. and at the bottom 68 ft. 6 in., the height being 42 feet exclusive of the falling handrail; the masonry of the entrance is 80 feet wide at the top, and 65 ft. 8 in. at the bottom, so that when closed the gate has an overlap on each side of 1 ft. 3 in. at the top, and 1 ft. 5 in. at the bottom. Along the bottom and ends, and on each side of the caisson, oak lining timbers 15 inches by 8 inches are bolted and made perfectly true, in order to fit closely against corresponding timbers fixed in the masonry, and make a joint as nearly water-tight as possible: the caisson would, of course, be pressed against one or other of the linings, as the level of the water was high or low on one side or the other. The beam of the vessel is 13 ft. 6 in., and with the timber linings therefore 16 inches more, or 14 ft. 10 in. The distance between the two plane faces of the masonry is 15 ft. 6 in. allowing a clearance of 8 inches for the width of the caisson.

The vertical frames are 18 inches apart, formed of strong angle iron; to them are riveted with butt joints the iron sheathing plates $\frac{9}{16}$-inch at the bottom, gradually decreasing to $\frac{3}{8}$-inch at the top. The side plates project 12 inches all round the bottom and ends, in order to admit the bolts for securing the wood frames which fit the masonry on the outside. In addition to the interior frames *of the bottom and the ends*, a series of strong plate beams are riveted to the projected sheathing outside, so as to prevent the external pressure from causing any yielding of those parts. Along the bottom the cross beams are not so close as those up the ends, in order to insert strong wooden keelsons on which the caisson rests when in its place. The whole is surmounted by a timber deck, forming a bridge of communication between the opposite sides of the lock when the bridge is closed.

You will perceive that the sides of this caisson being flat, it does not possess the advantages of a curved body to resist the strains upon them; they therefore, in addition to the framing I have been describing—which is simply that required for a curved caisson—have powerful stringer-plates 2 ft. 6 in. wide, at each deck, and gussets at the angles; indeed the structure is as stiff as it almost *can* be. The amount of deflection was proved at different heights of water from 18 feet to 38 ft. 4 in. The deflection, with 18 feet of water was $\frac{1}{16}$-inch; with 38 ft. 4 in. of water it was $\frac{9}{16}$-inch, which was the greatest deflection observed.

It is a question, whether making this caisson slide on *rollers* would not be an advantage, as they would guide it at the bottom; but Mr. Scamp's objection to rollers was, that if they got out of order, they would be difficult to repair at so great a depth beneath the water;—and the choice between rollers and no rollers must be left to the judgment of the engineer.

In conclusion, I may observe, that the use of caissons of the old construction, when pumping is necessary, is objectionable by reason of the time and labour necessary to be expended in the operation of docking or undocking any ship, whereby a tide may perhaps be lost. That, under ordinary circumstances, where economy is a consideration (and when is it not?), and when dock entrances of large size have to be closed, and also where the position would not impede the floating of it away, Mr. Scamp's "self-acting" caisson (if I may use the term) may be employed. And also, that the sliding caisson (which it has been the immediate object of this lecture to introduce) possesses the advantage of speed in working, and may be used in any situation.

The conditions required for this caisson were:—

1st. To resist a pressure of about 40 feet depth of water.

2nd. To make a perfectly water-tight joint, the lock having sometimes to be used as a dry dock.

3rd. To be worked across the entrance with facility and great dispatch.

4th. To avoid the usual labour, and cause of great delay in the working of ordinary caissons by pumping.

That all these conditions have been successfully carried out, I think you will have gathered from the observations I have made upon it. And I also think you will appreciate the talent of the engineer who contrived so excellent a work, and the skill of Mr. Fairbairn who executed it.

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Subjoined are further particulars respecting this dock and caisson.

The dimensions of the entrance to the lock are 80 feet wide at the top, and 43 feet deep from the coping line to the top of sill. The low-water line of spring tides is about 18 feet above the sill, and high-water line about 36 feet. The lock entrance was designed with a view of admitting vessels at every state of the tide.

The joint for the whole length, with any depth of water outside, and the lock dry, is at all times perfectly water-tight. The operation of working is performed by a few men only at a capstan, and it can be taken out across the entrance or back again into the camber, in from eight to ten minutes. Pumping is not necessary, as the caisson is ballasted to the depth required, and the tide is permitted to rise and fall within.

The only peculiarity requiring further to be explained is this. Supposing the caisson to be ballasted at 2 inches above the floor at low water, at high water it will have a buoyancy equal to the displacement of the materials of which it is constructed, for the space of the rise of tide, which is equal to about fifteen tons.

If ballasted at high water, it will sink on the floor at low water with an equal weight. To counteract this, ballast-trucks are provided in chambers at either end, and level with the deck, and are brought out as may be required, to suit the depth of water the caisson is required to work in. An upper ballast-tank is provided, which is filled from the fire-main, for cases when the caisson is required to be kept across the entrance, the lock being used as a dry dock.

The permanent ballast in the bottom of the caisson may be regulated for any depth by opening a man-hole for access to the air-chamber, in which the permanent ballast is placed. This man-hole is near the bottom of the caisson, and accessible when the lock is empty.

Besides the sliding caisson, there are five others, one at the inner end of the lock, one between the two basins, and three to dock entrances; these are, in form, construction, and general management, similar to ordinary caissons, differing only in dispensing with the great labour and delay required for ordinary caissons by pumping. By the following brief explanation the method adopted for avoiding the great expense and delay of pumping will be clearly understood.

The caisson is ballasted to the depth required for obtaining stability; at about that depth sluice-doors are provided, one on each side, the bottom being about an inch above the water-line, and at the same level the deck of tidal-chamber is formed. An upper ballast-tank is provided above the highest water-line, with a trunk communicating with the lower tidal deck, and to the bottom of this trunk a valve is provided.

When it is required to sink the caisson, water is supplied from the fire-main to the ballast-trunk, which will sink the sluice-doors below the water-line; the doors are then opened, and the water will flow in, and the caisson will continue to sink; the valve at the bottom of the tank is kept closed.

For lifting the caisson, the sluice on each side is opened, and the valve at the bottom of the trunk; all the water above the tidal line will pass from the tank. The caisson being relieved of that load, will rise, and the water from within will continue to flow out until the whole has escaped, and the sluices are above the water-line, and the tidal-deck is free; the sluices are then closed, and the caisson is perfectly under control. During the operations of sinking and lifting the caisson, care is required to guide the stems accurately in the grooves. When the caisson is sunk in its place, as much water as may be necessary is supplied from the fire-main to the upper ballast-tank; and when it is required to lift the caisson, the valve below is opened, the water escapes, and the caisson floats.

The despatch with which caissons of this kind are managed, will depend on the provision made for supplying water from the mains, and for admitting the water by the sluices. Ample provision for these purposes being made, a very short time only is necessary for sinking or lifting caissons of this description.

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In connection with this subject, we append some observations relative to the Keyham Caisson, by Lady Bentham, addressed to the Council of the Institution of Civil Engineers:—

At the meeting of this Institution, on the 9th May, 1854, the paper read was "A Description of the Sliding Caisson at Her Majesty's Dockyard, at Keyham, Devon," by Mr. William Fairbairn, C.E. This paper related, that "Caissons for closing the wide entrances of docks were first suggested in this country by General Sir Samuel Bentham; that since his time they have been somewhat extensively used, although the objection of occupying a considerable time in having the water pumped out of them, and it being necessary to float them entirely away from the opening before a vessel could pass, rendered them only applicable for special localities." It is to these objections that the following observations are principally limited.

It appears that the caisson at Keyham was designed by Mr. Scamp, and that the iron work for its construction was confided to Mr. Fairbairn. The means he employed for giving it strength add a feather to the rich plume which adorns that gentleman's cap. It is Mr. Scamp's originality of invention that is questioned, as relates to valves, the means of giving buoyancy to the caisson, and of sinking it into its place without need for *pumping* water into or out of it.

Sir Samuel's first proposal for a floating dam, as it was then called, was in 1798, for closing the entrance of the great basin in Portsmouth Dockyard; his plan was approved of by the Admiralty, the caisson built accordingly, and put into its place at the opening of the basin 12th January 1801. A copy of the General's proposal was printed in No. 1317 of the *Mechanic's Magazine*, November 1848; as was also the copy of a private letter from the master-shipwright of Portsmouth Yard, giving an account of the successful first employment of the caisson.

On reference to that proposal, it will be seen, that after speaking of the ballast requisite to give the caisson stability, the General went on to say: "What little additional weight it will require to keep the vessel from rising out of the groove at the time of high water, is to be obtained by letting water into one or more of the cisterns formed in the vessel immediately under the deck. This water would of itself run out of the cistern at the time of low water, even at neap tides, by means of the *panstocks* or *valves*, as shown in the profile."

From that proposal, it is evident that no pumping was requisite for raising water out of Sir Samuel's caisson at Portsmouth. However, he being scrupulously exact in providing for extreme cases, added, that if "at the time of high water it should be required to open the gate on the sudden, the water in this case must be pumped out of the cisterns." In similar circumstances, it does not appear that the water in Mr. Scamp's cisterns could be got rid of otherwise than by *pumping*.

From the above, it seems clear, that in respect to valves for draining the Keyham caisson from water, no advance has been made upon the established practice of half a century; but to assure myself of accuracy in this particular, I applied to a gentleman who had been for many years the master-shipwright of Portsmouth Yard; he has in consequence informed me, that "in regard to any novelty in the idea of admitting water to the caisson by means of *panstocks* or *valves*, I have to say, that I have never known a caisson without such an arrangement. It is a notorious fact, that the caissons at the Royal Dockyards are weighted with water admitted in such a way, and that the water is let out by opening the *valves*. Some alteration has been made since the introduction of iron caissons in the method of opening the valve—a screw is used for that purpose, but that is only a simple mechanical contrivance to carry out the same principle; and that General Bentham had no less the merit of the valve than he had of the caisson itself." It was in respect to the valve that Sir Samuel's caissons differed from foreign examples, as in those water was *pumped* out.

Sir Samuel's caissons being said to be applicable only to special localities, has been negatived by his having introduced them in the appropriation of an old work, the boat-camber in Portsmouth Yard, to docks for one, two, or three frigates at pleasure, the entrances to which at their different lengths were closed by the same caisson; but as other difficulties are alleged, it was thought desirable to obtain information from a gentleman who had had long experience in our principal dockyards. To inquiries on this subject the reply was, "I have much pleasure in informing you that I never found any inconvenience in floating this caisson (General Bentham's) out of its place, either at Portsmouth or any other yard where I have been."

The time consumed in opening or closing an entrance remained to be ascertained. At Keyham, it is stated to be effected in ten minutes for the opening, and eight minutes for the closing; but whether this be the *average* time, or only some special occasion, is not mentioned. The reply I obtained from Portsmouth was as follows: "The *average* time required to float the caisson out of or into its place is about ten minutes." Thus, in regard to time, the difference between the original caisson and that at Keyham is hardly appreciable, seeing that in one case the time is on an *average*, in the other (apparently) but one occasion. If, as has been said, the water at Keyham is supplied by the fresh-water pipes, that may cause the two minutes' difference in sinking the caisson.

As to the superior advantages of a rectangular caisson, that must remain an engineering problem. In the proposal of 10th September 1798, it is stated as follows: "Instead of a flat bottom of woodwork and side walls of masonry, the whole is of masonry, in the form of a reversed arch...... A *floating dam* is made to fit water-tight into a groove wrought in the arch of masonry, by which means the entrance will be shut up, and the water will be kept in or out of the basin...... This floating dam, which is built much in the form of a navigable vessel," &c. in continuance of its description, afterwards goes on to say, "the curvature given to the sides, at the same time that it affords a degree of capacity to the vessel sufficient to make it support the weight of the superincumbent bridge, together with a sufficient quantity of ballast to give it stability, enables the sides likewise the better to resist the pressure of the water at the greater depth."

## SCIENTIFIC TRAINING FOR PRACTICAL PURSUITS.

*A Farewell Address delivered to the Students in the School of Engineering, Trinity College Dublin*, 1854. By ROBERT V. DIXON, A.M.

As my official connection with the University is drawing to a close, and I am now addressing you for the last time from the Chair of Natural Philosophy, I am anxious to avail myself of the present opportunity to make a few remarks on some matters connected with your studies here. These remarks will mainly refer to the character of the training by which this school seeks to prepare its students for the arduous and responsible duties of the profession they purpose to follow, and my chief object in laying them before you is to satisfy you of the soundness of the principles on which that training is conducted, and to stimulate and encourage you to avail yourselves, honestly and earnestly, of the advantages now offered you. Such an appreciation of the true character of the studies in which he is engaged is always valuable to the student; it tends to reconcile him to many an irksome and tedious task, braces him to encounter many an apparently insurmountable difficulty, and raises him above a mere routine discharge of his prescribed duties. But in the case of the studies in which you are engaged, this knowledge is specially important. Until very lately, the utility of scientific instruction—instruction, that is, in principles—to persons embarking in what are called, emphatically, practical pursuits, such as the occupations of the Engineer, the Machinist, and the Manufacturer,—has been, if not expressly, at least practically denied in this country. Latterly, indeed, more correct views on the subject are beginning, though slowly, to make their way, but still it is far from being generally recognised that the only sound and legitimate mode of preparing a candidate for the practice of any art or occupation whatever, is, first, to teach him the principles on which the processes in such art are based, and then to train him in the application of those principles.

The correctness of these views has, however, long been felt in those continental states where engineering and manufacturing works of national importance are carried on under government supervision, as, for instance, in Holland, where the very existence of a large part of the country depends on the efficiency of the embankments and drainage works; in Northern Italy, where the fertility of extensive districts depends on their irrigation; and in France, where large and important manufacturing and mining operations are objects of national care and of government regulations. In all these cases, the superintendence of the responsible works alluded to is entrusted to pupils trained in scientific schools, and the wisdom of this procedure has been fully established by experience. Nor is it only for national works that pupils are thus trained in those states. Scientific instruction is given in their public educational institutions, in all branches of arts, or, in other words, students are instructed there in the principles of all those processes. I use this latter form of expression because, in the perception of its propriety is involved a forcible argument in favour of scientific systematic training for the practical arts. Many may be led from a want of sufficiently accurate information, or from a hasty view of the subject, to doubt the utility of a scientific education for a practical man, but none can deny that a knowledge of the principles on which a process is conducted will enable an operator to manage it more successfully. Of two manufacturers, one who knows what steps are essential to a process, and why—will, it must be admitted, be better able to guard against failure, if not to command success, than one who merely follows, without intelligence, a prescribed formula. Of two machinists, one who understands the nature of the force to be employed in a machine, and the principles of its action, must be a better artist than one who only makes the machine from plan and model. Of two engineers, one who comprehends the equilibrium of structures, and the action of material forces, must be a more able designer than one who merely works by empirical rules. My chief object in the following remarks is to justify and illustrate the application of these views to the particular case of the profession of the Civil Engineer.

And as the term Engineer, in its popular use, is an ambiguous one, being applied to makers of engines as well as to constructors of railroads and similar works, I think it necessary first to define the sense in which I employ it in the following remarks. I use the word, then, to denote a person whose professional occupation it is to design and superintend the construction of those great highways by which intercourse is effected, and trade and traffic carried on between different countries and different parts of the same country. This includes the making of roads, railways, and canals, with the construction of bridges, viaducts, aqueducts, docks, harbours, &c., and everything necessary for their completeness and permanence. I thus exclude from the duties of the engineer the making of the engines by which locomotion is effected by sea and land, and I think the term mechanist, or, more properly, machinist, should be employed to designate a person devoted to such occupation. I exclude also the functions of the architect and the builder; and the progress which has been of late years made in the division of labour, justifies me also in separating from the profession of the engineer the duties of the contractor. While thus detaching, however, these various branches of art from the business of the engineer, I must not be understood to imply that they have no connection with the latter, or that they all stand in the same relation towards it. Lord Bacon remarked long ago, that no science can be successfully cultivated by itself, and the same may be said of the arts. For not only is it true that any given art depends directly on others for its existence or its perfection, but there is also an indirect relation between them, similar to that referred to by Lord Bacon as existing between the sciences, by which their mutual progress is materially affected. Still, notwithstanding this intimate connection between various arts, not only may they be abstractedly considered as distinct, but experience and history have shown that the tendencies of the increase of civilisation, of the growth of capital, and of the progress of knowledge, have always been to isolate them in practice. Nor have these causes the effect merely of separating arts and professions previously combined, but also of producing new ones, by creating a demand for works or results of such importance and of such extent as to call for the services of a special class. Thus the progress of civilisation, and knowledge, and wealth has separated the professions of the oculist, the aurist, the dentist, and the surgeon; of the conveyancer and the pleader; of the common law and the equity barrister; has divided machinists into makers of locomotives and stationary steam-engines, and these latter into makers of land and marine engines. And the most striking instance on record, perhaps, of the creation of a new profession is in the case of engineers, a class which has been called into existence in these countries within the last thirty or forty years. For although individuals have followed the occupation at various periods during the last 120 years, as Brindley, Smeaton, and others, yet the calling did not attain the position and permanence of a profession until within the period I have mentioned; and since its establishment, with the rapid progress which characterises the development of all the recently-discovered arts and sciences, it has already detached itself from various branches of art accidently or necessarily connected with it at first. The earliest engineers were generally either machinists or builders, according to the nature of the works which they were called upon to execute; but by their labour, and ingenuity, and skill, aided by the requirements of the times, they gradually constructed a new profession, and further trained up a body of contractors, themselves constituting a distinct class, remarkable for their enterprise, intelligence, and zeal.

I have stated that the duties of the engineer are distinct from those of the machinist, the architect, the builder, or the contractor. I purpose now to inquire more particularly what those duties are, and to show that they may be taught scientifically,—that is, as I explained before, that the principles on which they depend are known, and may be communicated systematically to the student; and further, that he can be trained in the practical application of those principles where it is necessary that he should apply them himself, and in the mode of ensuring their application where they are carried into effect by others. And as I proceed, I will briefly notice the means provided in our School to effect these several objects.

The first duty of an engineer who is called on to construct a line of communication between two given points, whether by railway or canal, is to ascertain the course he will follow. To determine this, he must have a map or survey of the intervening country, with trial sections along the most desirable routes. On the accuracy of such surveys and sections much of the value of his decision will depend. It is accordingly essential that he should be able to test their accuracy either by personal examination, or by the aid of assistants of whose competence he has assured himself. The importance of this duty, moreover, and the liability to errors in the performance of it, arising either from wilful or unintentional neglect, especially in districts not previously examined with care, will always render it one which the young engineer will be liable to be called on to discharge in person. The art of surveying and levelling, therefore, with the necessary and indispensable adjuncts of plotting and mapping, is one in which he must be not merely acquainted with the principles, but also an adept in the practice. And there is probably no subject connected with his profession, on both the principles and practice of which more has been written, proving that in this department at least there is a very general impression that much valuable information can be conveyed to the student in a scientific and systematic form. But here I must take the opportunity of warning you against the not uncommon mistake of supposing that when a person understands how a thing is to be done, he can necessarily do it; that when he comprehends the principles and method of an operation, he will necessarily, and without practice, be an adept in the performance of it. This is, as I have said, not an uncommon, but not the less a most mischievous error. Wherever therefore, as in the present case, it is necessary for you to possess practical skill in any branch of your profession, remember that it can only be acquired by practice—that you can only attain to the power of doing a thing by doing it. Accordingly, you know that you are not merely taught here the principles of surveying and levelling, but that you are also required to practise those arts; that you are sent into the field, day after day and term after term, to make sections and surveys, at first under instruction, and afterwards by yourselves. This is one of those duties which, after you have mastered its principles, must always appear irksome and tedious; for this reason I dwell upon its importance now, and for this reason the Professor at the head of the School is so urgent with you, at the cost of much personal labour and fatigue, for the due performance of it. And, thanks to his indefatigable zeal in the discharge of this and the other onerous duties of his office,—and, I must add, to the diligence with which you and your predecessors in this School have devoted yourselves to this branch of your studies,—we are able to refer with satisfaction to convincing proofs of the skill attained by your pupils in this department.

The requisite surveys and trial sections having been carefully made and mapped, the choice of a route will, in most cases, be a choice between steep gradients and heavy works. The judgment of the engineer will be exhibited in the decision he will come to on this point. To guide his judgment, he will require, in the case of a railway, for instance, to know, on the one hand, the capabilities of locomotives and the expense of their working as affected by various gradients; and on the other, he must be able to calculate the cost of all the incidentals of the construction of a line, including its earthworks, embankments, bridges, viaducts, &c. For the former point he should know the theoretic capabilities of the locomotive engine, and also how far the mechanical difficulties preventing their development have been overcome.* He should know the theoretical relation between the power applied and the resistances to its action, and he should be acquainted with the experiments instituted to determine the value of the latter. Thus alone will he be able to interpret correctly the results of past experience, and apply them to new cases. Thus experiments are made, we will suppose, with locomotives of different constructions, on lines of different gradients, with various loads at different velocities, and in different states of weather, and the respective quantities of coal consumed, are ascertained. Now, it is only by applying the principles of mechanics to determine the relation existing between the force expended and the opposing resistances, that we can distinguish the effects of the latter, and determine their separate amounts, and so ascertain the expenditure of force necessary to overcome new combinations of resistances. It is for this reason that you are instructed in the theory of the steam-engine, and taught how to calculate its effects in the different forms in which it is employed. You have been taught how much is certain in this theory, namely, the mechanical principles, and how much is only probable, namely, the action of the steam when in motion and expanding, and the limits of the consequent uncertainty in the final results have been pointed out to you. You have also been shown how the ordinary resistances have been experimentally investigated, and to what different degrees of certainty their values are known.

With reference to the different structures requisite for the completeness of a railway, you have in like manner been first instructed in the mechanical principles involved in the determination of the conditions of their equilibrium. The application of these principles would be, in most cases, a matter of little difficulty, if the forces whose equilibrium we investigate acted merely on material points connected by rigid mathematical lines. This, however, is very far from being the actual state of things, and hence rises considerable difficulty in the application of mechanical principles. The structures, in fact, of which we are at present speaking, are all designed to support weights and resist strains. Besides these forces, however, the material masses of which they are composed are themselves in all their particles subject to the action of gravity, and of those molecular forces to which we give the names of cohesion, attraction, and elasticity, and to which what is commonly designated the strength of materials, is due. The amount and nature of these latter forces, the knowledge of which is obviously essential to the determination of the strength and permanence of structures composed of materials subject to their action, can only be learned from experiment; and considerable attention has been devoted to this subject in recent times. The labours of Professor Barlow and Mr. E. Hodgkinson in this department have been specially brought under your notice, and a form of apparatus of the same construction, and on the same scale, as that employed by the latter gentleman in one department of his investigations, has been provided for the use of the School, and you are thus enabled to repeat and extend his experiments. Besides this, you have had your attention directed both by the Lecturer in Mechanics and the Professor of Engineering, to several theoretical and experimental investigations on the same subject in these countries and on the continent, both by individuals and by public commissioners, and you have thus been put in possession of the most recent and most accurate information on this important point. Besides the knowledge of the abstract principles on which the equilibrium of structures depends, and the nature and strength of the materials of which those structures are usually composed, you have also been instructed in the ordinary forms in which those principles are applied and those materials employed, as well as in those more remarkable and striking applications of them which are justly regarded as the triumphs of modern engineering skill. And for the clearer comprehension of the subject, models of all these different structures are being provided for the School, and a large collection is already in our possession.* These, with the numerous drawings amassed since the formation of the School, leave little to be desired in the way of illustration, and the labour which you have expended in copying several of them has at once improved your skill as engineering draughtsmen, and familiarised you with the countless details involved in actual work.

And now, the route of our railway being determined, and the requisite works designed, it is necessary to make an estimate of the expense, and draw up specifications for the use of the contractor. To instruct you in this department of your business the Professor of Engineering has compiled a list of the prices at which some public works have recently been executed, and also a collection of the most approved specifications of various important works, exhibiting not only the form in which such documents should be prepared, and the minuteness of the details into which they should enter, but also giving examples of the actual points to be attended to in them, the nature of the foundations, the materials to be used in the work, the manner in which these should be prepared and combined, and the cements with which they should be united.

And further to perfect you in this department, you are required, before presenting yourselves for the final examination, to complete a project of a railway or some similar work, in an assigned locality, furnishing complete and perfect surveys and sections of the line, its plans, estimates, and specifications of all the requisite works. This differs from what you may be required to do, in the actual practice of your profession, only in the absence of responsibility; I trust however, that the want of this stimulus to care and accuracy will be supplied by a conscientious anxiety honestly to discharge the duties imposed upon you here.

In most cases the active duty of the engineer terminates with the drawing up of the contract specifications, and it is only necessary for him afterwards to ascertain, on the part of his employers, their due fulfilment. This is owing to the fact that the great demand for the formation of extensive works has of late years called into existence a large and intelligent body of contractors, who stand between the designer and the artist, who carry out the plans of the former by the labour of the latter, and who thus occupy a position midway between the intellect which conceives and the hands which execute. As the interpreter of the gods of Olympus was a deity himself, and at the same time most eloquent in the language of men, so must the contractor be a man of superior intelligence, and at the same time intimately acquainted with the details of the mechanical crafts, essential for the execution of the plans which he is commissioned to carry into effect. Without the intervention of such a class the operations of the engineer would be greatly limited, and his facilities of cultivating the higher branches of his art greatly diminished. While, at the same time, the increasing intelligence and skill of the contractor compels the engineer, as Mr. R. Stephenson lately remarked, to exert himself to the utmost to hold that position in his profession which he is entitled to claim, otherwise he must "perish by this people which he made." And the only way by which he can retain this position is by deepening and widening his knowledge of the principles of his profession, and extending their applications.

The minuteness to which the engineer must carry the details of his specifications will depend to some extent on the character of the contractors expected to undertake the works. Thus in some instances the plan of centering for arches is prescribed by the engineer; in others it is left to the judgment of the contractor; and so of other details.

* To supply the students with the means of becoming thoroughly conversant with the details of the construction of the locomotive, a very complete and elaborately-finished model of the 'Pyracmon,' a goods engine on the Great Western (broad gauge) Railway, has been provided for the School. It is made to a scale of one-fourth, and is 6 ft. 6 in. long, and 2 ft. 4 in. wide; its cylinders are 4 inches in diameter, and 6 inches stroke. All the parts of the model represent faithfully in form, proportion, and material, the corresponding parts of the original, and the surfaces of the several joinings, valve-casings, cylinder-covers, &c., are so fitted by the process termed *scraping*, that they form air-tight joints without the intervention of packing. The whole machine may thus be taken asunder, and its several parts exhibited in detail.

* Among these may be noticed an interesting and nearly complete collection of timber bridges and cofferdams, all copied from recent works, and made to scale, and a beautiful working model of the lifting apparatus of the Conway Tubular Bridge.

It must be borne in mind, however, that there are occasions on which the engineer cannot count on commanding the services of contractors. In works of special difficulty, of novel design, or of unexampled magnitude, the engineer must be prepared to undertake the construction of the work himself. He may always calculate, however, even in such cases, on carrying out considerable portions of his details by partial contracts, remaining responsible for the success of the combination, and, perhaps, personally superintending and perfecting the more novel or more difficult portions of his design.

Again, in remote districts, in the case of small works, which it would not be worth while for established contractors to undertake, and in new colonies, where local contractors are not to be met with, the engineer must, as in the former case, be to a considerable extent, or altogether, the constructor as well as the designer of his own works. It is even conceivable that in cases of this kind he may be obliged to a certain degree to teach and train the artisans employed in the details, and the possibility of such contingencies will always induce the intelligent student to familiarise himself with the mechanical operations of the different trades employed in the arts of construction. Independently also of the cases where such knowledge will be indispensable, it will be of the utmost utility in many others. Hence, you are instructed in many handicraft details, in the mode of shoeing, bolting, and securing framing timbers; in the bonding of brick and stonework; in making templets from drawings for the stones of the different arches of ordinary and skew bridges, &c., and you are encouraged to take every opportunity, which does not interfere with your more immediate business, of making yourselves acquainted with such details as can be learned only in the shop of the carpenter, the forge of the smith, and the shed of the mason.

In the preceding remarks I have chiefly called your attention to matters connected with the construction of railways and ordinary roads. There is, however, a large field of engineering practice, and well worthy of constituting a distinct branch of the profession, connected with water-works of different kinds, canals, docks, and breakwaters, mill-works, irrigation, and draining. All these may be included under the term Hydraulic Engineering, and from their importance and specialties deserve to be detached from the business of the ordinary engineer. The progress of the profession appears to be leading to this, and already there are several distinguished engineers in Great Britain who devote themselves chiefly, or exclusively, to this department. The distinction between the branches, however, is not yet generally recognised, and accordingly we include instruction in hydraulics in our Engineerin' Course. Hydraulics may be said to be almost altogether a science o experiment. Theory is compelled to deal with the subject of the motion of fluids in such a narrow and limited form, that its results are of little use in practice, and we are obliged to appeal to experience to correct and extend them. The subject has not as yet met with the attention in Great Britain which it deserves, and the best information we possess is to be obtained from foreign writers. To render the knowledge derivable from these sources available to you, the Professor of Engineering is at present engaged in compiling a work embracing the results of the most trustworthy experiments on hydraulics, and the Lecturer in Mechanics has supplied you with a valuable treatise on the application of the mechanical principles to the theory of the Equilibrium and Motion of Fluids.

Among the other specialties of hydraulic engineering must be mentioned the character of the constructions it requires. Water-tight canals, reservoirs, aqueducts, and mill-courses; consolidated beds of irrigating rivers; dock and quay walls built on sites ordinarily covered by the sea, and from which its waters are excluded by gigantic cofferdams, or whose foundations are laid in deep waters by the aid of the diving-bell; and piers and breakwaters, in whose construction the engineer is engaged in an almost constant struggle with the most powerful forces of nature. The history of engineering supplies records of the triumph of ingenuity and skill over all the difficulties connected with works of this kind, and furnishes the educated student with the means of overcoming similar obstacles.

The remarks which I have made on the duties of the engineer will suffice, I trust, to explain and justify the course of study prescribed for you in this School. It is unnecessary for me to recapitulate or enumerate more particularly the subjects included in this Course. I should mention, however, that besides those to which I have referred in the preceding observations, it contains some others, a knowledge of which, if not directly essential to the engineer, is of the utmost utility to him. These are, Chemistry, Geology, and Experimental Physics. A knowledge, indeed, of portions of these sciences cannot be dispensed with; and the more complete an engineer's acquaintance with them is, the more perfect is his professional education. The engineer cannot be ignorant of the properties and mode of action of that great power, whose application to locomotion has, it may be said, created his profession. He must be acquainted with Physics, therefore, so far at least as concerns the science of Heat; and the universal agency of this force over all the materials employed in his constructions renders this knowledge still more necessary. Again, an acquaintance with the laws of Geology, so far at least as they concern the distribution of minerals, is of the greatest service to the engineer; and in new countries, where the sources of iron and coal are as yet unknown, it is all but necessary: and a practical knowledge of Chemistry is essential, so far as will enable the student to ascertain by analysis the properties of minerals, and of the materials requisite for the composition of cements.

Such is a brief sketch of the character of the instruction given in this School, and of the subjects included in its Course. It only remains for me now to say a few words on the results which we expect it to produce; for it may be said, "You have shown that the course of instruction prescribed for students in your School is necessary, but is it sufficient? Will it supply the place of genius, or remedy the want of experience? Are your men to be compared with those who, like Brindley and Smeaton, and Telford and Stephenson, by the force of their genius covered the land with trophies of their skill; or can they take their stand beside those who have acquired their knowledge, not from books, but from actual experience?" To these demands I would reply, that the objections implied in them might be brought with equal force against all our professional schools,—against those of Divinity, Law, and Medicine, as well as against that of Engineering. It is a mistake, as I remarked to you on a former occasion, to suppose that the latter profession is more practical than the former, and consequently requires a different method of training for its students. Every profession, in fact, may be regarded in the twofold aspect of an art and a science. It is an art so far as it has a practical aim and object; it is a science so far as the rules for the attainment of that object have been reduced to system and method The man of the greatest genius will derive advantage from a knowledge of the principles deduced from the results of the able men who have preceded him. By the possession of such knowledge he will be placed in the same position as if he had himself centuries of experience; and the man of inferior genius will be enabled to repeat at least what has been done before him by others, if not to achieve new triumphs and overcome new difficulties. Instruction in the principles of the science of a profession will not place the man of original talent and the man of moderate abilities on the same level in the practice of the art, but it will raise them both to positions far above those to which they could have respectively attained without it.

Again, no amount of theoretical instruction will make a man an adept in an art. To be a successful practitioner, he must have had practice. In all properly constituted professional schools, therefore, the students are trained in the practice of those duties which they may be called upon to discharge personally when they commence the practice of their profession; skill in the higher branches they must acquire during their professional career. Thus I have shown that special provisions are made to give you practical instruciotn in all those operations which you may be required to execute in person when commencing your professional course. In fact the only reason why other modes of training professional students are called and assumed to be more practical, than those adopted in scientific schools, is not because they are really more practical, but because they are merely practical.* They only show how things are done, we both show thisand also why they are so done. They give the rule alone, we give the rule and the reason. And so they are styled practical because they are nothing else, and we are assumed not to be practical because we are something more.†

You will conclude, then, from what I have said, that we profess to train students here so that on leaving the School they will be able to conduct and superintend such works as are ordinarily intrusted to young men commencing the practice of their profession. Their subsequent progress of course will depend on their natural aptitude for the pursuit they have chosen, as well as on the information they have acquired, and the training they have undergone here. They are started with great advantages; they may be distanced by competitors who have had less, but who would certainly have distanced them far more rapidly had they also possessed similar advantages at the outset. And as some of our students may be wanting in natural aptitude for the practice of their profession, so others may be unable to avail themselves to the full extent of the advantages of their training here. Those who are materially deficient in this respect are stopped at the annual examinations, and never obtain their diploma. Of those, however, who leave our School after completing its Course, and receiving its attestation of their professional acquirements, though some, owing to the causes alleged above, may never rise to distinction in their profession,—we feel confident that none will bring discredit on themselves or the School, by failure in the discharge of routine duties.

In a word, then, we cannot create genius or aptitude for this or any other profession, but we can develope it where it does exist, and we can remedy the want of it to a certain extent by teaching the results of the genius of others. We can train the powers which a student does possess, and render them much more efficient, whether in the case of genius or mediocrity, than they would have been without our teaching, and

* Thus Unitarians are so called, not because they, as distinguished from Trinitarians, believe in the unity of the Deity, but because they believe merely in the unity of the Godhead, and not in the plurality of the Persons. And again of two brothers, both equally good lawyers, if one be also a mathematician, he will be distinguished among his friends by the latter appellation, and the other will be called simply the lawyer.

† The fallacy consists in inferring that because a person possesses a certain quality, to the exclusion of all other qualities, he therefore possesses it to the exclusion of all other persons. That because X equals Y only, therefore X only equals Y.

we can prove that our method of training is superior to any mere empirical method, in developing the native powers, and supplying their deficiency. As to practical instruction, again, we profess to render our students adepts in all those branches in which the young engineer must possess skill when commencing his profession, and we facilitate his acquisition of skill in the higher branches during his professional career. It is, however, in the independent practice of the latter alone, that our students, or those brought up under any other system, can acquire complete professional skill. We can no more give these opportunities of independent action before a man is started in his profession, than we can create natural aptitude; but we can in the former, as in the latter case, supply to a considerable extent its want, and prepare the student to derive the full benefit from it when he obtains the opportunity.

I have not alluded on the present occasion to the advantage you enjoy in this School from the facility afforded you of pursuing along with your professional studies the Course in Arts. Of the importance of this Course to general intellectual training, to the development of the faculties and the cultivation of judgment and taste, as well as its connection with the professional studies of the schools, I have treated at some length on a previous occasion, and accordingly I do not consider it necessary to detain you by any further reference to the subject at present.

It remains for me, in conclusion, to bring under your notice a few facts connected with the history and progress of our School. It has been in operation nearly thirteen years, and was three years later in its origin than the Engineering Schools of Durham and King's College, London, the first established in Great Britain. It is as yet the only School of the kind connected with any of the older Universities. Since its formation it has admitted 242 students, and issued seventy-eight diplomas. In 1849 the plan was adopted of granting special honour certificates to such students as distinguished themselves at their final examination. Of these ten have been granted for proficiency in the immediate business of the profession, five in Mechanics and Experimental Physics, and thirteen in Chemistry and Geology. These twenty-eight certificates have been awarded to seventeen students, several obtaining more than one. Of the seventy-eight pupils who have obtained the diploma of the School, some have abandoned the profession, but by far the greater number are now engaged in the practice of it, and are scattered over all parts of the world. These are all making their way in their profession by honourable, independent exertion; for such success as they are enjoying they are indebted to no patronage or favour beyond that which granted them an opportunity of showing their qualifications and their skill. I hope, however, that when the character of this and similar educational establishments is better known and appreciated, and when the services which they render to the profession and the public are consequently recognised, the diploma of our School will be regarded, not indeed as an absolute test of professional merit and skill, but as not only furnishing an evidence of respectable professional attainments, but also as giving a claim to special patronage and encouragement. That it will, in a word, hold the same rank and enjoy the same privileges that the diplomas of medical and surgical schools hold in their respective profession, and that government and other public bodies will recognise it in a similar manner.

And now, Gentlemen, I take my leave of you and of the Engineering School. I thank you for the attention with which you have listened to me on the present and on all past occasions. During sixteen years' experience as a College and University Lecturer and Professor, I have never met with more diligent, more attentive, or better conducted students than those in the Engineering school. I heartily wish you that success in your profession which such a course of conduct here entitles your friends to anticipate for you hereafter, and I trust that through your professional career you will be influenced not only by an honourable ambition to obtain professional eminence, but also by the higher motive of a desire to improve to the utmost the talents committed to you by your Creator, and that you will refer all your actions to His most holy will, as to His gracious Providence you owe all your powers.

## RAILWAY SIGNALS.

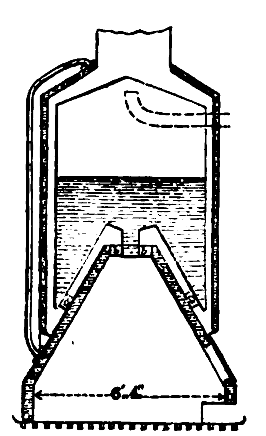
Bernard Cowvan, *Patentee*, October 11, 1853.

This invention consists in placing, at suitable intervals along the entire length of railway, a number of bells or sounding apparatus in connection with endless wires, having a series of cranks so connected to them, that on the movement of a lever at any portion of the line, the whole of the bells will be caused to ring, and thus indicate in each direction that a stoppage has occurred. This wire may also be connected by cranks and wires with a series of semaphore arms, the lower ends of which are forked, in order to conceal when down lamps attached to the semaphore posts.

## THE BEE-HIVE BOILER OF LAKE ERIE.*

By Thomas Drew Stetson.

The steam navigation of the lakes of North America is distinguished by the occasional employment of a form of boiler, locally known by several different appellations, among which the "bee-hive" is, perhaps, the most strikingly descriptive. The annexed engraving is designed to represent a vertical section through the whole structure, and also through a "water jacket," with which the larger sizes are invariably provided, and which may be considered, in fact, as it certainly is in effect, a part and parcel of the boiler. The boiler proper is in two portions, one above the other, with suitable connections, to allow a free circulation of the contents. A connection is made by a copper pipe leading from the topmost point of the jacket to a position near the base of the main shell, down which the full heated water and a small modicum of steam is assumed to be continually flowing. This pipe is the only means of communication. The check-valve, not shown in the engraving, is attached to the jacket near its lower rim, and although the vessels are rarely propelled with independent feed-pumps of any description, the arrangement renders it practically certain that this important appendage will remain at all times nearly or quite filled with water. There are four connections *a a*, located at equidistant points in the horizontal plane. The connections *b b*, are two in number, and serve to convey the current of steam and highly-heated water from the lower into the upper shell, while the lower and more liberal passages may be supposed, in some cases at least, to convey a current in the opposite direction. It may be sufficient to know, however, that the deposit, in all cases, settles to the bottom of the lower shell, at which point, as well as at the lower edge of each of the outer portions, ample provision is made for its removal. In the fresh clear water of the lakes, these boilers have been uniformly successful, and although difficult of repairs, may very naturally be inferred from the novelty of the form, and the whole might be, for various theoretical considerations, pronounced necessarily short-lived and troublesome, the experience of the few years it has been in use, seems to indicate a rather unlooked-for durability, and the style has won itself a degree of local popularity which might, perhaps, be more widely extended.



The boiler of the propeller *Troy*, from which the engraving is prepared, has been now more than three years in service without any expenditure for repairs.

The *Boston*, a small propeller of some 16-inch cylinder, running between Cleveland and Ogdensburgh, was the first on which this boiler was adopted, and the repairs have, to this day, cost about 250·00 dols. The whole credit of the experiment is due to Mr. L. Parmalee, a boiler-maker, of Cleveland, by whom most or all of this description yet in use have been constructed. The heating surface is somewhat more efficient than the same extent in any of the usual forms, the actual evaporation being taken as the index. The boiler of the *Troy* presents about 700 square feet of fire surface, aud 31½ grate area. This supplies plenty of very dry steam at a pressure of 80 lb. above atmosphere, to a cylinder 3 ft. 6 in. stroke, and 28 inches diameter, making 55 revolutions per minute, and cutting off at ⅝-ths of the stroke from commencement, the throttle being always wide open.

The boiler of the *Troy* having been constructed when the material was quoted at a much lower figure, the cost would be no data for comparison. A boiler now building in this form, and of almost precisely similar dimensions, is to cost 2250 dols. The form and proportions allow a very considerable fluctuation in the water level, without exposing any surfaces to the direct action of the fire, and the large unobstructed water surface allows, what is rarely obtained in upright boilers, tolerably perfect separation of the vapour from the water, the per centage of water mechanically

* From the 'Journal of the Franklin Institute.'

suspended, being, for obvious reasons, much less than in any of the ordinary forms. The steam is withdrawn from a point near the apex of the upper shell, the pipe bending down and coming out through the side, as indicated by the dotted lines.

Clothing with felting, or other non-conductors, is a refinement not yet introduced to any considerable extent, either on these or other steam boilers in those localities. Under all the circumstances, with natural draught and ordinary firing with hard wood, the results in several propellers most readily accessible, are as follows, the steam in every case being represented as "plenty" at a pressure of from 68 to 80 lb.; throttle-valve never used:—

The *Niagara*, with a fire surface of 575 square feet, a grate surface of 28·3, and a cylinder 3 ft. 6 in. by 22 inches, makes 58 revolutions, cutting off at ⅝ths.—The *Forest Queen*, fire surface 537, cylinder 3 ft. 6 in. by 28½, makes 56 revolutions, cutting off at ½.—The *Westmoreland* (propeller, 200 feet in length), fire surface 710, grate 44, cylinder 3 ft. 6 in. by 28 inches, makes 58 revolutions, cutting off at ⅝.—The *Prairie State*, *Michigan*, and *Ogdensburgh*, each presenting 700 feet of heating surface, and 38½ feet grate area, with cylinders 3 ft. 6 in. stroke, and 22 inches diameter, make from 54 to 60 revolutions, loaded, cutting off respectively at ½, ⅝, and ½ stroke.

The consumption of fuel in the furnaces of these boilers, which are termed "conical vertical," in the Official Reports of the Inspectors, are recorded as follows:—*Niagara*, ¾-cord of wood per hour; *Forest Queen*, ⅞-cord; *Westmoreland*, 1 cord; *Boston*, ¾-cord; *Prairie State*, 1 cord; *Michigan*, ¾-cord; *Ogdensburgh*, ¾-cord.

There are now floating on the waters of Lake Erie, eleven or more of these boilers. The water-spaces adopted are uniformly 4 inches thick around the furnaces. The water-jackets are somewhat thinner at the base, diminishing to only about 2 inches thickness at the top. The iron is ⅜-inch thick for the principal boilers, and ¼-inch for the jacket, stayed every 5½ inches. Water bottoms can probably be fitted without difficulty, but are not yet much employed, the bottom being usually a simple water pan supported on plain bars about two inches square.

This bottom affords a trifle less direct protection to the keelsons, but gives free access to water in case of accident, and allows a fire to make itself apparent in less time than does a brick bed. The size of the boiler now in use, ranges, in external dimensions, from 4 ft. 6 in., to 7 ft. 4 in., and in perpendicular height, from 10 feet to 17 feet. Its use is unobstructed by patent, or any "intention" to monopolise whatever advantages it may be found to possess.

## MEANS OF ECONOMISING THE USEFUL EFFECT OF PRIME MOVERS.

— BANNER, *Patentee*, October 31, 1853.

THE economy of power, or of the useful effect produced by prime-movers generally, is a subject which has attracted the attention of practical men perhaps more than any other. While others have devoted their thoughts to finding new means of "creating" power, with a view to superseding water and steam power and animal force, such men as Babbage, Rennie, and Stephenson have endeavoured, by experiments, inductive reasoning, and practical applications, to economise the means already at hand. Economy of power is an economy of means, and if the fractions of the units of force be taken care of, the pounds and horse-powers will in time take care of themselves. That much power is lost at present in the greater number of cases where steam or water power has to be substituted for animal force, is evident to all who are practically acquainted with the details of the construction of machinery and the formulæ by which the force required is calculated. It has been a received maxim, even among the most practical men employed in such works, to "keep on the safe side," and indeed so important has the necessity of this error on the right side been deemed, that what is called a "horse-power" in mechanics represents a much *greater* force than that given by the dynamometer when applied to the animal itself. "One 'steam' horse-power is equivalent to 33,000 lb. avoirdupois raised one foot high per minute, but an 'animal' horse-power is equivalent to only 22,000 lb. raised the same height in the same time, or in other words, to drag a canal-boat 220 feet per minute, with a force of 100 lb. acting on a spring; therefore, a 'steam' horse-power was originally made (practically, for the purpose of erring on the safe side) equivalent in working efficiency to one living horse, and one-half the labour of another,—so that a 60-horse power engine had to be calculated to do, according to the formula, the work of 90 horses."* We do not hereby mean that all practical men make this allowance, but when Watt fixed the steam horse-power at 33,000 lb., it was because *up to his time*, a loss of 45 to 50 per cent. was taking place between the practical results and the original theoretical calculations, as founded on his experiments. But this amount of 50 per cent. is not all that is allowed by practical engineers when the power of an engine required to put into motion certain combinations has to be ascertained. There is friction and inertiæ of the masses to overcome; and although one portion is set in motion before the remainder of the machinery is geared on, yet in many cases the fly-wheel has to be set in motion at first starting, and *invariably* some little allowance must be made for "lost force."

The consideration of the economy of force in all such cases becomes a matter requiring the serious attention of our scientific men, and is one of the greatest possible importance to manufacturers and artisans generally; but unfortunately, we are so much in the habit of using that which has been found to answer in practice, without that due observance in the application of the changes which strict economy would dictate, that much loss of power, and consequently waste of capital, are the necessary results.

The means by which power can be economised, and made to yield a maximum amount of mechanical useful effect, is one which has not occupied the attention of practical men so fully as it deserves; a few have done little more than call the attention of others to certain facts under our daily observation, but little has been done towards settling formulæ for actual construction. Mr. Babbage, in his chapter on the Accumulation of Power in his 'Economy of Machinery,' says: "Whenever the work to be done requires more force for its execution than can be generated in the time necessary for its completion, recourse must be had to some mechanical method of preserving and condensing a *part of the power* exerted previously to the commencement of the process; this is most frequently accomplished by a fly-wheel, which is in fact nothing more than a wheel having a very heavy rim, so that the greater part of its weight is near the circumference; it requires great power applied for some time to put this into rapid motion, but when moving with considerable velocity the effects are exceedingly powerful." "In some of the ironworks, where the power of the steam-engine is a little too small for the rollers which it drives," continues Mr. Babbage, "it is usual to set the engine at work a short time before the red-hot iron is ready to be removed from the furnace to the rollers, and to allow it to work with great rapidity until the fly has acquired a velocity rather alarming to those unused to such establishments. On passing the softened mass of iron through the first groove, the engine receives a great and very perceptible check, and its speed is diminished at the next and each succeeding passage until the iron bar is reduced to such a size that the ordinary power of the engine is sufficient to roll it." Here we have an instance of increased useful effect caused by increased velocity, and this means of increasing the momentum is very frequently used, but the wear and tear is considerable, and it can only be applied in such cases as will admit of increased velocities. If, however, instead of increasing the momentum by an increased velocity, we produce the same result by adding to the weight of the fly-wheel, we obtain the additional advantage of working at a uniform speed governed by a regulator.

We need scarcely remark, for the use of ordinary readers, that "momentum," which represents the force or power of the body in motion, is ascertained by the multiplication of the weight or gravity by the velocity, and that by increasing either the one or the other (the weight or the velocity), the result of the calculation can be brought to be precisely the same, under totally different circumstances of weight and velocity. Mr. Babbage gives us an instance of greater power being obtained by increased velocity; and in existing systems, such as the arrangements at ironworks, the only means left, without some addition to those arrangements, is, by increasing the velocity;—but more efficient means of economising the power at hand would at once be acquired if arrangements were made for increasing the momentum without increasing the velocity. The plan proposed by Mr. Banner, and for which he has obtained a patent, consists in increasing the momentum of the main shaft A, (fig. 1) of the machinery by the addition of a supplementary fly-wheel B, after the works have been set in

* See Dr. Ure's 'Philosophy of Manufactures.'

motion and their inertiæ overcome. The great advantage of this mode of increasing the momentum is, that the uniformity of speed regulated by the governor C, is not interfered with. As regards new works, it will lead to a more just appreciation of the

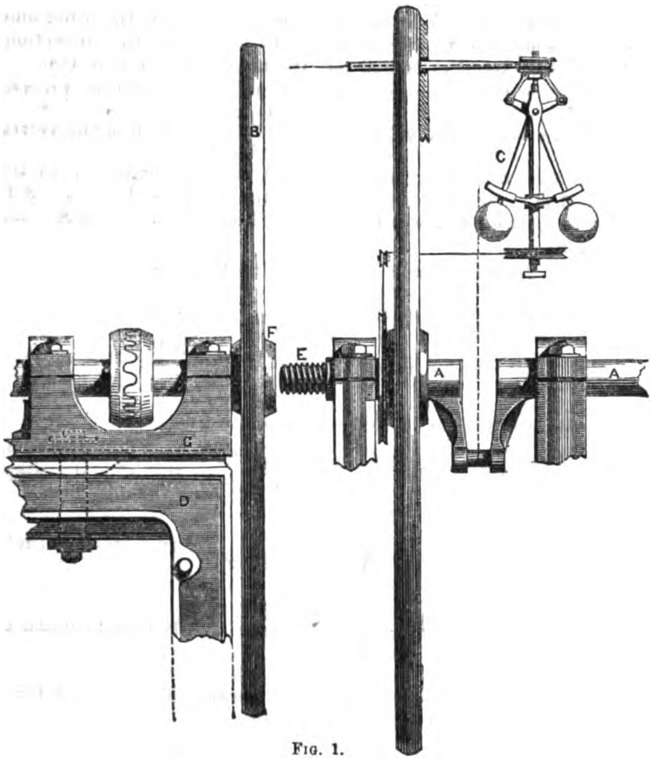



FIG. 1.

minimum power required to produce the necessary results,—while, when applied to present machinery, a gain of power will be realised.

As there are many instances existing where the prime-mover is not found sufficient with the present arrangements for the requirements of the proprietors, the means proposed will be valuable to effect what otherwise would require new combinations. The supplementary fly-wheel B, proposed by Mr. Banner can be geared on to the main shaft A, in the ordinary way; but in his specification he secures the means of bringing the supplementary wheel on a small stage D, working upon rails, or otherwise, with little friction, up to the end of the shaft. He then makes use of a thread, cut in the end of the shaft at E, which is allowed to work in a female-screw in the boss F, of the supplementary wheel. The wheel is allowed to move longitudinally along the bed G, of the stage, until taken up by the main shaft. The motion thereby communicated to the secondary wheel has the advantage of being gradual.

The improvements introduced by the patentee in the construction of water-wheels are chiefly applicable to the overshot construction, and consist in the increase of power caused by keeping a maximum weight round nearly the entire half of the periphery of the wheel on its falling side, which in Mr. Banner's wheels is in most cases *reversed* by, firstly, substituting curved instead of straight or polygonal buckets, differing from the curved shapes introduced of late by Poncelet, Rennie, and Fairbairn, in so much that the line of direction of the centre of gravity of the mass of water in each bucket is, at all times during the rotation, at right angles to the horizontal tangent of the curve; and secondly, by keeping a constant pressure of water on very nearly the whole of the loaded or falling side of the wheel, as shown in the general vertical section, fig. 2, where A, is the axis; B, the wheel; and G, the buckets. The supply is allowed to flow in at C, after being regulated by means of the sluice H, and to escape at B; and waste is prevented by the solid retaining wall, buttress, or other convenient means, according to particular cases of construction, the lower part of the curve of which is brought near to the working parts of the wheel, without being sufficiently so to touch or in any way impede its action, whilst the upper part of the wall is made either vertical or with an inward batter, to lessen the cubic quantity of water in the space I. This arrangement allows of the direct action of a body of water pressing vertically on the tangential parts of the curves of the buckets, and thereby the supply is economised, and the maximum power of leverage

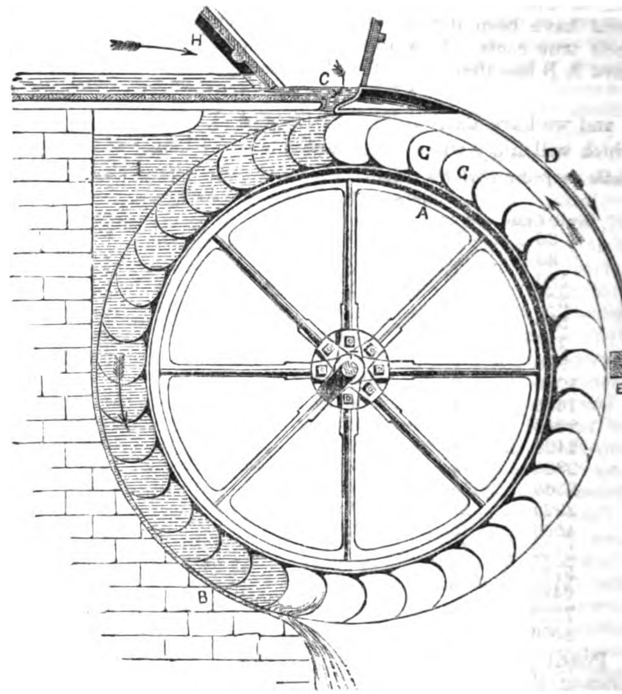



FIG. 2.

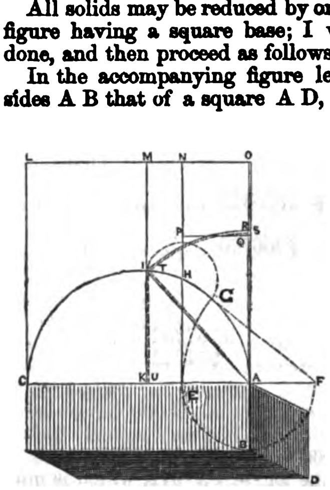
exerted on the periphery of the wheel. At D, is shown a protecting plate of zinc or other material fixed to the cross-beam E, for the purpose of carrying off ice when the supply is excessive; the aperture C, being protected by a grating.

## GEOMETRICAL EXTRACTION OF THE CUBE-ROOT.

SIR—As mechanics and others are often desirous of knowing the side of a cube equal to a given solid, I send you herewith a simple method of finding the same, which, when the correction is employed, gives the result generally true to the $\frac{1}{10000}$th part of the root sought; or, if the root were equal to an eighth of a mile long, the error would not amount to an inch, and more often not to $\frac{1}{10}$-inch.

All solids may be reduced by ordinary methods to a rectangular figure having a square base; I will suppose this to have been done, and then proceed as follows:—

In the accompanying figure let the solid D C have one of its sides A B that of a square A D, and let A C be the other side.




Produce A C to F, and make A E, A F, each equal to A B; on A C describe the semicircle A H C; from the centre F describe the arc E G, cutting the semicircle at G; draw E H perpendicular to A C, cutting the semicircle at H; make H I equal to H G; draw I K perpendicular to A C; *then* A K *is the side of the cube required very nearly.*

When it is desired to have the root much more correctly, continue as follows: Complete A O L C the square of A C, and produce E H, and K I to meet O L at N and M; join A M, cutting E N at P; draw Q P parallel to A C to meet A O at Q, and make A R equal the radius A I; make R S equal to one-third of Q R, and with radius A S cut the semicircle at T; draw T U perpendicular to A C; *then* A U *is the root required, and true to the* $\frac{1}{10000}$*th part generally.*

To do what is here described takes much less time than the description does. As the proof of the above depends upon a very tedious and intricate calculation, I subjoin a table of cubes whose roots have been determined by this method, giving alongside their true roots. It would appear from them not advisable to have A B less than $\frac{1}{10}$th of A C. The method described gives

$$AU^3 = AC \times AB^2;$$

and we have also, $AT^3 = AC^2 \times AB$,

which will apply when the square side is the longer of the two.

*Table to prove that the Method described gives a very close Approximation to the True Cube Root.*

| Given Cube. | A B. | A K. | A U. | True Root. |
|---|---|---|---|---|
| 20 | 1· | 2·5932 | 2·7172 | 2·7144 |
| 80 | 2· | 4·3424 | 4·3090 | 4·3089 |
| 180 | 3· | 5·7401 | 5·6469 | 5·6462 |
| 320 | 4· | 6·9451 | 6·8406 | 6·8399 |
| 500 | 5· | 8·0218 | 7·9374 | 7·9370 |
| 720 | 6· | 9·0127 | 8·9622 | 8·9628 |
| 980 | 7· | 9·9427 | 9·9329 | 9·9329 |
| 1280 | 8· | 10·8270 | 10·8577 | 10·8577 |
| 1620 | 9· | 11·6770 | 11·7447 | 11·7446 |
| 2000 | 10· | 12·5000 | 12·5995 | 12·5992 |
| 2420 | 11· | 13·3016 | 13·4251 | 13·4257 |
| 2880 | 12· | 14·0858 | 14·2282 | 14·2276 |
| 3380 | 13· | 14·8558 | 15·0081 | 15·0074 |
| 3920 | 14· | 15·6118 | 15·7682 | 15·7675 |
| 4500 | 15· | 16·3625 | 16·5101 | 16·5097 |
| 5120 | 16· | 17·1025 | 17·2359 | 17·2355 |
| 5780 | 17· | 17·8353 | 17·9466 | 17·9463 |
| 6480 | 18· | 18·5620 | 18·6433 | 18·6434 |
| 7220 | 19· | 19·2834 | 19·3275 | 19·3276 |
| 8000 | 20· | 20·0000 | 20·0000 | 20·0000 |

Possibly, with a more extensive table of logarithms than I possess, the value of A U might have proved even nearer the truth than this Table shows.

When the cubic contents of a solid are given numerically to find the side of the cube, it may be solved geometrically, thus:—Divide the given cube by any square number, whose root represents one of the sides A B of a rectangular solid equal to the given cube, and the quotient will be the remaining side A C. The Table shows that, when the best diviser is taken, A B will be rather less than $\frac{1}{2}$ A C. Set off the lengths of these sides with a scale, and proceed to find the root by the method described.

*Example.*—Let 571787000 be the given cubic contents. Divide this by any square number, say 422500, whose square root, 650, is one of the sides, A B; the quotient, 1353·342, is the other side A C. When the process is complete, including the correction, A U will be found to be 830·046, the true root being 830·000.

To prove the numerical value of A U by calculation, proceed as follows:—Find the value of $\frac{3\,AB^2}{AC + 2\,AB}$, which is the versed sine of the angle A G; also, $AE = AB$ is the versed sine of the angle A H. By the construction of the figure $<AI = 2<AH - <AG$, from which A K, the versed sine of the angle A I, can be found.

Now the line $AI = AR$ is $= \sqrt{AC \times AK}$,

And, by proportion, $AQ = \frac{AB \times AC}{AK}$;

Hence, $AS = AT$ is $= \frac{AQ + 2AR}{3}$;

And, finally, $AU$ is $= \frac{AT^2}{AC}$.

From the preceding data we derive the following formulæ to determine the value of A U:—Put $b = AB$; $c^3 =$ the given cube, whose root is $c$; and $x =$ sine of $\frac{1}{2} < AI$.

(*a.*) Sine of $\frac{1}{2} < AG = \sqrt{\frac{3\,b^6}{c^3\,(c^3 + 2\,b^3)}}$; hence, $\frac{1}{2} < AG$ may be found by a table of sines.

(*b.*) Sine of $\frac{1}{2} < AH = \sqrt{\frac{b^3}{c^3}}$; hence $< AH$ may be found by a table of sines.

(*c.*) $< AH - \frac{1}{2} < AG = \frac{1}{2} < AI$; hence, sine of $\frac{1}{2} < AI = x$ may be found by a table of sines.

(*d.*) Then, $\frac{1}{9c^3}\left(\frac{b^2}{x^2} + \frac{2\,c^3 x}{b}\right)^2 = c = AU$, the required root.

The given example is worked out by logarithms as follows:—

(*b.*)
$b^3$ ......... 2·812913 × 3 = 8·438739
$-c^3$ .......................... = 8·757234
2) — 1·681505
$\frac{1}{2} < AH$ = 43° 52′ 13″·3 .............. — 1·840752
× 2
$< AH$ = 87 44 26·6
$\frac{1}{2} < AG$ = 36 34 58·7 ............................................................ — 1·773872

(*a.*)
$b^6$ ......... 2·812913 × 6 = 16·877478
3 .......................... = ·477121
17·354599
$-c^3$ ......... 8·757234
$-(c^3 + 2b^3)$ ...... 9·049620
— 17·806854
2) — 1·547745
— 1·773872

(*c.*) $\frac{1}{2} < AI$ = 51 9 27·9 or, $x$ = ·778875, whose log. is — 1·891468.

(*d.*)
$b^2$ ......... 2·812913 × 2 = 5·625826
$-x^2$ ......... — 1·891468 × 2 = —1·782936
696450 .......................... 5·842890

$c^3$ ......... 8·757234
+ 2 ......... ·301030
+ $x$ ........ — 1·891468
8·949732
$-b$ ......... 2·812913
6·136819

+ 1370310 ............................................................ 6·136819
2066760 ........................ 6·3152896*
× 2
12·630579
$-c^3$ ......... 8·757234
$-9$ ......... ·954243 ——— 9·711477
2·919102 .................................. 830·046, the root.

If from the logarithm 6·315289 (*) be taken 1·477121 (= log. 3), then $\frac{1}{2}$ the sum = 2·919084 is the log. of 830·012, which is much nearer the true root. This is equivalent to

$$\sqrt{\tfrac{1}{3}\left[\left(\frac{AC \times AB}{AI}\right)^2 + 2AI \times AB\right]} = \sqrt[3]{AC \times AB^2},$$

an equation which admits of accurate geometrical construction.

It must be understood that the preceding complicated calculation is only intended to prove the accuracy of the geometrical method, for one-third the logarithm of the given cube number would give the root at once.

J. B. HUNTINGTON.

3, *Furnival's Inn, June* 7, 1854.

## MEMOIR OF WILLIAM LAXTON.

We regret to announce the death of William Laxton, Esq., the founder and proprietor, and until recently the editor, of this *Journal*.

William Laxton was born in London, on the 30th March, 1802, and was the son of William Robert and Phœbe Laxton, descended from an old midland counties family. His father was an eminent surveyor, and, after receiving a sound practical education at Christ's Hospital (Blue-coat School), he was brought up to the same pursuits. Having a strong sense of duty, as well as great love for his profession, he set himself steadily to work, and gradually made himself master of every department. His talents were not shining, but he possessed a mind of great capacity, and liberal and enlightened views, so that, both in the extent of his acquirements and mode of their application, he had advantages which few men possess; and had he continued in full practice as an engineer or architect, he would have left behind him works of a valuable class. Few persons came into communication with him who did not recognise his sound practical knowledge; but only those more intimate were aware of his earnestness in all professional pursuits, not only to execute everything thoroughly and soundly, but likewise to carry out that development and those improvements of which the undertaking might be susceptible. Although not disposed to launch out into the regions of speculation, he was always disposed to regard every subject by its higher considerations; and it is perhaps to be regretted that he was on many occasions so far diffident that he gave way in such respects to the convictions of those of less enlarged mind. We dwell upon these traits of his character, because, although he left behind him no great engineering or architectural work, yet during a long period he exercised a very considerable influence, directly and indirectly, on the minds and views of professional men.

We revert to his early training, because in that consisted his peculiar advantages for the career he subsequently pursued, and because it affords an example well worthy of the imitation of the student. In the days of his pupilage, there were not the advantages we now possess. Self-study was then the sole resource of the well-disposed pupil; and although he who succeeds under such circumstances acquires at the same time strong self-control, and a good and independent discipline, yet those wanting in strength of mind are apt to give way, and forego the advantages of learning for the allurements of idleness or pleasure. Almost the only Society, in those days, for promoting scientific knowledge was the "City Philosophical Society," which held its meetings at the house of the celebrated lecturer, Mr. Tatham, in Dorset-street, Salisbury-square, of which Mr. Laxton was an active member, and in which many scientific men of the present day learnt the rudiments of their profession. Now, there are few towns without a school of design or drawing-school, and a mechanics' institute and moderate library, and no great town without special institutions of a higher class. In the metropolis we have now public schools in which the rudiments and accessories of professional education can be acquired, and where the indolent have the spur of rivalry and the supervision of teachers to restrain them to a right career; while those of ardent mind find in our noble institutions the means of gratifying the most zealous love of knowledge. William Laxton, like many other distinguished members of the profession in the present day, had, by self-teaching, to make himself a master in his profession; to learn day by day, and never to the last moment to relax in the study of pursuits wherein the accumulated exertions of men of genius of many nations are constantly introducing modifications, changes, and improvements, applications of new substances, and original modes of construction. Thus, in railway construction he began at an early period; and nevertheless, in the present day, it may be said that all the knowledge of the past is superseded and worthless, and, unless a man had been continually learning, he must begin anew. In a brief generation a new profession was created, and carried to a great height of progress and prosperity, bringing with it its own authorities, its own forms, and its own influence. The architect can still revert to Vitruvius and Palladio, and he finds not a book in his library which is obsolete or unprofitable; but he nevertheless has come to a time when new branches of study have had to be acquired, and when the disposal of new materials has to be determined. In the progress and movement of architecture which we have of late years witnessed, some men have been prepared to take part because they have been the authors of the movement, and it has been by their means maintained; but others have had to learn and study to keep pace with the requirements of the age. No young man therefore must think that a few years of schooldom will thoroughly fit him for any branch of the profession, or that his studies can ever cease while anything yet remains to be learnt; and in William Laxton he will find an example of a man who, with a moderate education and limited means, and while constantly absorbed in active practice, nevertheless made himself master of the highest branches of professional knowledge, and was able to exert a very great and beneficial influence on that portion of society of which it was his lot to be one of the members.

At an early period, Mr. Laxton took a part in railways, with the importance and rapid progress of which he was fully impressed. He surveyed and laid down several lines at various periods, but he was not so fortunate as to obtain the construction of any line. Among other undertakings, he was connected with the Hull and Selby, City and Richmond, Surrey Grand Junction, Hull, Lincoln, and Nottingham, Gravesend and Brighton, Lynn, Wisbeach, and Ely, and Thames Embankment Railway. He also designed a viaduct to overcome the difficulties of Holborn Bridge.

Hydraulic engineering was a favourite pursuit of Mr. Laxton, and one in which his acquirements were very great. It is to be regretted that he did not complete a work which he had designed on this subject, and for which he had prepared extensive materials. In all communications on hydraulic engineering, in its several branches, which appeared in this *Journal* he took a deep interest, and many valuable suggestions proceeded from his pen. On subjects of internal improvement connected with this branch he was much consulted, and of late years his practice had become much connected with it. He designed and laid out the waterworks at Falmouth and Stonehouse, in which he introduced many improvements, and designed works for Penzance and Brighton. In the movement for the improved supply of water to the metropolis he took a leading part as a professional man, and was joint engineer with Mr. Robert Stephenson, M.P., in the promotion of the Watford Water Company, for supplying London with water from the chalk formation; he was also much consulted by the Wandle Water and Sewage Company, and gave evidence for both Companies before the parliamentary committees.

Although a man of quiet and unobtrusive manners, Mr. Laxton was a man of much earnestness in his views and opinions; and as his time was wholly and sedulously given to his business, so his thoughts very naturally were similarly directed. Devoting himself very steadily to his own improvement, he looked with much interest on everything that conduced to the advancement of his own profession; and he was led seriously to consider the manner in which the profession was represented, and the channels available for the circulation of professional information. About eighteen years ago, the only architectural periodical was the *Architectural Magazine*, a work of much merit, edited by the late J. C. Loudon, but which, from its plan, was not calculated to take in a sufficiently wide and varied range of subjects. Mechanical engineering was only represented by the *Mechanic's Magazine*, and civil engineering had no especial organ. It appeared to Mr. Laxton that a work of a new character and scope would be appreciated by professional men, and would be calculated materially to advance professional interests; and after careful consideration, he determined on establishing this *Journal*. To this undertaking he was led by no speculative bias, and he carried into it those habits of application and of perseverance which marked him in all pursuits. It was his object to establish a journal which, while it afforded a medium for ready communication and correspondence, should be of a standard character as a work of reference and authority. He adopted a larger size of page, in order that he might give, in addition to wood-engravings, plates of buildings and machinery.

For the task of editing such a journal Mr. Laxton was well fitted, by the extensive range of his acquirements in every branch of professional, practical, and theoretical knowledge, while, with a progressive and liberal mind, he brought to bear a calm and sound judgment and well-tempered disposition. He had few preferences or prejudices to contend with, and none of a personal nature; and, what is very difficult among professional men and artists, he was able to maintain an independent course, although tempted by many occasions when sectional feeling ran high. If at any time he displayed a warmth of tone, it was when professional or public interests were at stake. In such a career there were few men of whom he earned the ill-will, of many the respect.

In a public course pursued during so many years, and embracing so many measures and events of interest, it is difficult to give any other than a general character, but there are nevertheless several marked features deserving of observation. In the defence of professional interests and the organisation of a professional constitution, there can be no doubt that this *Journal* has exercised a very material influence, and the recognition by the government of the claims of professional men, partial though it be, is owing to the spirit infused by it. The successful resistance of the marine engineers to an insidious measure of the Board of Trade was celebrated by a public dinner to Mr. Laxton, as the Editor of this *Journal*, and honorary secretary to the Associated Engineers. The division of labour which has taken place by the separation of the civil and mechanical engineers was likewise much assisted by the co-operation of the *Journal*. His own experience of the condition of practical hydraulics caused him to take a very active part in promoting that organisation of hydraulic engineering which seems likely to result in its constitution as an established art and as a distinct profession. At all times he was most active in resisting the usurpations of the government on independent practitioners, and the substitution of military engineers for civilians. Had the resistance been persisted in, or were it now resumed, the policy of the course recommended with regard to the military engineers would be fully justified, and the services of those valuable officers be confined to that sphere of honour where they are so much required, and the Ordnance survey be committed to competent civilians of high professional reputation.

Setting aside other services to architecture, Mr. Laxton was materially instrumental in contributing, on every suitable occasion, to the growth of that new and energetic spirit which distinguises our architects in the present day, and more particularly in raising the tone of architectural criticism. On this head, he was always exceedingly desirous of obtaining suitable co-operation, and of enlisting the contributions of those desirous of promoting this object.

It was a source of very great gratification to Mr. Laxton, that not only was his design fully realised, but his exertions attended with reputation and success. Not only has the circulation of this *Journal* been large, and its columns been quoted and translated in every part of the world, while it has received the contributions and co-operation of many of the most distinguished members of the profession.

Many of the communications in the *Journal* have been published in a separate form, including the "Life of Robert Stephenson," by Mr. Hyde Clarke; the translation of Arago's "Life of Watt," a "Life of Trevithick," "Contributions to Railway Statistics," and other works by the same author; "Meteorological Observations," by Dr. Drew; "Lectures on Architecture," by Samuel Clegg, jun.; &c.

In connection with the *Civil Engineer and Architect's Journal*, Mr. Laxton took part in some other publications. He purchased the weekly publication, *The Architect and Building Gazette*, and conducted it for some time, till he united it with the *Journal*.

A work, which originated with his father, and has been conducted for thirty years by Mr. Laxton and his brother, was the *Builder's Price-Book*, bearing his name, and into which he introduced many improvements, and has been for a long time considered a standard work in the profession and in the courts of law, and is so well known as to be circulated all over the kingdom.

These literary occupations required much time and attention, but Mr. Laxton, nevertheless, was deeply engaged in other pursuits. The numerous connections he acquired in relation to the *Journal* caused him to be entrusted with numerous commissions, which were the foundation of a large agency for the procuration of British and foreign patents and registration of designs.

Among other appointments, Mr. Laxton was intrusted with the surveyorship to the Baron de Goldsmid's estate at Brighton, and laid out, under the Baron's direction, a large part of the new town adjoining the west end of Brighton, in the parish of Hove, on which he built and designed many of the houses and effected many improvements. His design for the new church was not however carried into execution. From the period of its formation, Mr. Laxton was also surveyor to the Farmer's Fire and Life Insurance Company. On technical points in surveying he was much consulted as an authority, and was employed in many important cases.

The labour devoted by Mr. Laxton to these various pursuits, there can be no doubt, undermined his constitution, and, after suffering from two severe attacks, he died on the 31st May, of epilepsy, at the age of fifty-two. His remains were privately interred in the family vault in St. Andrew's burial-ground, Gray's-inn-road; the funeral being attended by the builders from Brighton, and by many who held him in high esteem, to whom his decease became known, and who were desirous of manifesting their respect for his life and labours.

The only son, Frederick William Laxton, F.S.A., was brought up under his father, and was a matriculated student in the Department of Applied Sciences of King's College, but afterwards commenced a course of legal studies in the chambers of an eminent special pleader, and was called to the degree of barrister-at-law by the Honourable Society of the Middle Temple. The younger brother of William Laxton, Henry Laxton, was likewise brought up as an architect, and having taken a considerable share in his brother's occupations, has succeeded to the conduct of his various professional engagements.

Mr. William Laxton was a citizen of London and a liveryman of the Haberdashers' Company, admitted in 1823.

## REVIEWS.

*On the Atmospheric Changes which produce Rain and Wind, and the Fluctuations of the Barometer.* By Thomas Hopkins, M.B.M.S. (Second Edition.) London: Weale. 1854.

Science having now attained nearly the limit of possibility of discovery in the region of distant worlds, and having descended into the bowels of the earth till she has exhausted every variety of geological formation, seems to have bethought herself at last, that there may yet be something worth her attention in that mixture of gases constituting the air we breathe, and that it may be as well to discover by what laws the vital air is regulated. We are happy to find symptoms of increased attention to the subject of meteorology, and though our own opinion is, that before we can generalise, we need more extensive series of observations, and those reaching through long periods; yet we thank every man who, with modesty and in a philosophical spirit, contributes his quota towards the explanation of atmospheric changes—changes, wonderful and at present inscrutable for the most part, on the causes of which the best observers hold conflicting opinions. Mr. Hopkins has done good service by publishing the work at the head of this article,—he has carefully examined hypotheses, showing the inconsistency of several with observed facts, and in some cases has brought forward opinions of his own, which deserve study and consideration. His object is truth, and his sentiments are expressed with a modesty and carefulness which recommend them to the attention of all who take an interest in the subjects on which he treats.

The author commences with an explanation of the production of wind, in which he endeavours to show that the usual theory on the subject—namely, the unequal heating of the surface of the globe, and consequently of the air near it by the sun—does not produce those powerful winds which blow within the tropics. "The heating of the surface of the globe and of the air near it by the sun is not," says he, "a sufficiently powerful cause to produce those winds;" and he proposes to show, "that the heat which is taken up by vapour in the process of evaporation, is carried away to various parts of the atmospheric regions, and in those parts is liberated on the vapour being condensed; and that it is this liberated heat which produces that inequality of temperature which causes the greater part of those aerial movements, called winds, on different parts of the surface of the globe." A considerable portion of the author's labours go to establish this theory, upon which we shall pronounce no decided opinion,—it is certainly suggestive, and the cause he assigns no doubt produces some of those variations in atmospheric temperature which are the immediate cause of the rise of some portion of the air, and the in-rush of a colder stratum below. But many other points of very general interest are discussed in this volume, and they are handled with ability, and will ensure attention from his readers. As meteorology has only just begun to be studied, we welcome this book, and shall be glad to see the subject frequently discussed; at the same time, we would point to the fact that what is wanted are observers—let their number be multiplied, and their observations carefully taken with approved instruments. Thus we shall have in the course of time a more extensive collection of facts, whereby we may more readily arrive at general laws. At present, we consider meteorology to be a science of observation, and observation only; and we shall be happy if our remarks tend to add to the number of active members of the Meteorological Society, from whose unobtrusive labours the science is deriving most valuable assistance.

As a specimen of the author's style in describing natural processes, we subjoin the following account of the diurnal process of evaporation (p. 191):—

"When the sun advances above the horizon it warms the surface of the globe, and not only increases evaporation of water, but heats that portion of the atmospheric gases that is near the surface—which portion rises probably in separate streams or columns—cooler columns at the same time descending to the surface and taking the place of the warmer. This process goes on as the sun rises higher, until at some particular time, depending on the locality and the season, the ascending columns reach a height sufficient to enable the expanding gases to cool and condense some of the vapour which is intermingled with them. This ordinarily takes place from 9 to 11 o'clock, or say at 10 in the morning, from which hour condensation is warming the atmospheric mass in the locality. This warmed mass, a mixture of gases and vapour, as it ascends, is acted on by the different laws of cooling, of condensation, and of expansion by heat, which the constituent parts of the atmosphere obey; and the result is the formation of a buoyant column of cloud, of greater or less thickness, according to the quantity of vapour that has been condensed. The whole local column being thus made lighter by the liberated heat, presses with less force on the surface of the earth, and consequently on the barometer. This diminished pressure is however effected through the liberated heat driving a portion of the material of the atmosphere, the gases, from the heated part to other parts of the atmospheric space; and thus we find that the heat just liberated by the condensation of vapour counteracts the increased pressure of the aqueous matter, which is at the same time passing into the atmosphere in the form of vapour. For it is here contended that the vapour that had been produced from 4 to 10 in the morning, is, soon after the last-named hour, not only raised but condensed,—deprived of a part of its heat, and converted into minute particles of water, which float in the gaseous atmosphere as a cloud, and as such, undoubtedly form a part of the whole atmosphere and contribute to its weight. It is not therefore through a reduction of the quantity of aqueous matter in the local atmosphere at this period of the day, that the barometer falls, but that fall is caused by the expanding power of liberated heat driving from the heated vertical column a part of the ponderable gases which previously existed within it, and, in that way, by removing a part of the material of the atmosphere, causing the remainder to press with less weight on the barometer."

In parting with our author, we would strongly recommend his book to all who are interested in the subject, assuring them that they will here find material for thought and sound information on various points which are only to be found scattered through the publications of various learned societies.

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*The Practical Surveyor's Guide, containing the necessary information to make any person of common capacity a Finished Land Surveyor, without the aid of a Teacher.* By ANDREW DUNCAN, Land Surveyor and C.E. London: Sampson Low. 1854.

WE have received from the other side of the Atlantic a professed new royal road to learning—"A means to make any person of common capacity a finished land surveyor, without the aid of a teacher;" which said means, so far as we can gather from our perusal, are nothing more or less than a *rechauffé*—a gathering of old formulæ culled from the best and well-known authorities. We, however, leave Mr. Duncan to state his own merits, premising that several of the methods and improvements that he claims to have invented have been frequently employed in this country. The work will be found to contain, amongst a variety of other matter, Mr. Duncan says, "A description and design of a new instrument whereby distances are found at once without any calculation. A new method of surveying any tract of land by measuring one line through it, with a geometrical demonstration of the same. A geometrical method of correcting surveys taken with the compass, to fit them for calculation. Description of an instrument by the help of which any gentleman may measure a map by inspection, without calculation. A new and short method of calculation, wherein fewer figures are used than in the common method; also, the Pennsylvania method. Laying off lots with a pole, plummets, &c. &c."

## STEAM ENGINES.

JOHN MILNER, *Patentee*, October 6, 1853.

(*With Engravings, Plate* XXVI.)

IN an engine constructed in accordance with this invention, the Patentee employs two working cylinders with pistons, piston-rods, and connecting-rods constructed in the usual manner, and connected to two cranks placed at right-angles to each other on the same shaft, preferring to make one of these cylinders of greater capacity than the other. The cylinders are provided with valves worked by cams or eccentrics, and so arranged that steam may be admitted from a boiler into the top of the first or smaller cylinder until the piston has made half its stroke, and then shut off. A communication is then opened between the top of the first cylinder and the top of the second one, whose piston is then at the top of its stroke. Both pistons will now descend until the small one has reached the end of its stroke, when the second piston will be at half stroke. The motion still continues, and the first piston begins to return, and reaches its half stroke when the second piston has completed its stroke. The steam which was at first contained in one-half of the first cylinder, will now have expanded so as to fill the whole of the second cylinder and one-half of the first cylinder. The steam is now discharged into the condenser or into the atmosphere. When the first piston reaches the end of its stroke, as above mentioned, the steam from the boiler is admitted to the bottom of the first cylinder until its piston has made one-half of its stroke. The steam is then cut off, and the half-cylinder full of steam is allowed to expand into the bottom of the second cylinder in the manner above described. Thus the second cylinder is open to and receiving its steam from the first cylinder during the whole of the stroke of the second piston. For reversing the engine, a passage or passages and a valve or valves are arranged so as to connect the top of the first cylinder with the bottom instead of with the top of the second cylinder, and *vice versa*. The relative dimensions of the two cylinders, and the point at which the steam is cut off from the first cylinder, may be varied according to the degree of expansion required. The position of the cylinders may be vertical, horizontal, or inclined, and the angle of the cranks may also be somewhat varied.

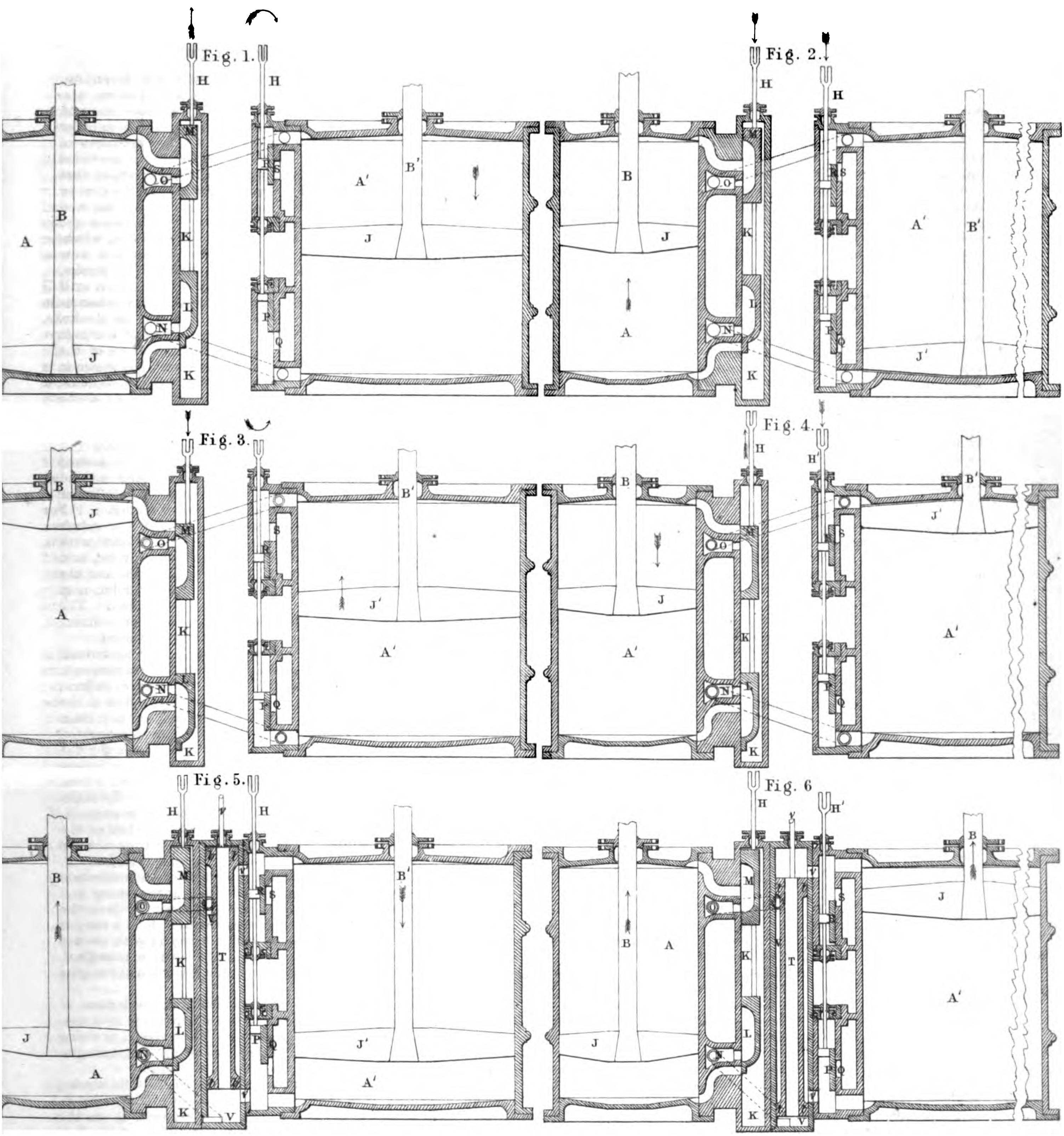
Figs. 1, 2, 3, and 4, in the annexed Plate, are longitudinal sections of the cylinders and valves, showing the arrangements for producing the required effects. A, A′, are the cylinders; B, B′, the piston-rods; C, C′, the connecting-rods attached to the cranks D, D′, placed at right angles to each other on the main shaft E. F, F′, the eccentrics, and G, G′ their rods, connected respectively to the valve-rods H, H′. I, I′, are guides for the piston-rods. J, J′, the pistons of the first and second cylinders respectively. K, a valve-box which is supplied with steam from a boiler, which steam is admitted by means of the slide-valves L, M, into the first cylinder. The eduction passage N, from the bottom valve L, communicates with the bottom of the second cylinder A′; while the eduction passage O, from the top valve M, communicates with the top of the second cylinder. P, is a plain flat slide-valve working in a valve-box in communication with the bottom of the second cylinder A′, and opening and closing a passage Q, leading into the condenser, or into the atmosphere when the engine is non-condensing. R, is a similar slide-valve, working in a valve-box communicating with the top of the second cylinder A′, and opening and closing a passage S, leading into the condenser, or to the atmosphere when the engine is non-condensing.

In fig. 1, the piston J, of the first cylinder is at the bottom of its stroke, and the piston J′, of the second cylinder is consequently at its half-stroke or thereabouts. The valve L, is rising in the direction shown by the arrow, and is just beginning to admit the steam from the boiler under the piston J.

In fig. 2, the piston J, has made about one-half of its stroke, and the piston J′, is at the bottom of its stroke. The valve L, is now descending, and, having shut off the steam, is on the point of opening the communication from the bottom of the first cylinder A, to the bottom of the second cylinder A′

In fig. 3, the piston J, has arrived at the top of its stroke, and the piston J′, is consequently at or near its half-stroke. The communication between the bottoms of the two cylinders is still full open. The piston J, now begins to descend until it reaches its half-stroke or thereabouts, when the piston J′ has completed its upward stroke, as shown in Fig. 4. The steam which at first

# MILNER'S IMPROVEMENTS IN STEAM ENGINES.




J.R Jobbin

was contained in one-half or thereabouts of the first cylinder A, has now expanded so as to fill the half of the first cylinder A, and the whole of the second cylinder A'. The valve P, is now opened, and the steam escapes from both cylinders to the condenser. Both pistons descend until the piston J has reached the bottom of its stroke, as shown in fig. 1, when the valve L, ascends, shutting off the communication with the second cylinder, and admitting steam from the boiler into the bottom of the first cylinder as before. The eduction valve P, continues open until the piston J' has reached the bottom of its stroke, as shown in fig. 2, when the steam from the bottom of the first cylinder is again admitted as before. The valves M, and R, at the tops of the cylinders, act in a similar manner to the valves L, and P, at the bottoms of the cylinders.

The steam is thus caused to expand in the proportion which the sum of half the contents of the first cylinder and the whole of the contents of the second cylinder bears to half the contents of the first cylinder. In the figures the cylinders are so proportioned that the contents of the second cylinder are about two and a-half times the contents of the first cylinder, so that the steam will thus be expanded to about six times its original volume. The relative dimensions of the cylinders may be varied to obtain different proportions of expansion.

In the above description the engine is described as continually moving in the same direction; but in some cases it is required to have the power of reversing the engine. For this purpose the eccentrics F, F', are made loose upon the shaft, and are driven by stops fixed on the shaft. When the motion of the shaft is reversed, the one set of stops leave the eccentrics, which remain stationary until the other stops come in contact with them, and carry them round in the reverse direction. In addition, however, to this motion of the eccentrics, it is necessary to alter the course of the steam, so that in lieu of its passing from the bottom of the first cylinder to the bottom of the second cylinder, and from the top of the first to the top of the second cylinder, it may be compelled to pass from the bottom of the first to the top of the second cylinder, and from the top of the first to the bottom of the second cylinder. Figs. 5, and 6, are sections of the cylinders and valves, showing also a reversing valve T, adapted for producing the aforesaid change in the course of the steam. U, is the valve-rod which passes through a stuffing-box. The valve T, consists of a tube having a piston *t*, at each end, packed to fit the valve-box V. The steam from the eduction passage N, at the bottom of the first cylinder A, is conveyed by a pipe or passage (indicated by dotted lines) to the bottom of the valve-box V, and is thus put in communication with the interior of the valve T. The steam from the eduction passage O, from the top of the first cylinder is conveyed by another pipe or passage (also indicated by dotted lines) into the space between the valve-box V, and the exterior of the valve T. Two passages or ports *v*, *v'* communicate from the valve-box V, respectively with the bottom and top of the second cylinder A'. When the valve T, is raised into its highest position, as in fig. 5, the steam from the bottom of the first cylinder passes to the bottom of the second cylinder, and the steam from the top of the first cylinder passes to the top of the second cylinder, and the effect is the same as before described in reference to figs. 1, 2, 3, and 4.

When, however, the valve T, is made to descend into the position shown in fig. 6, the course of the steam is reversed so that the steam from the bottom of the first cylinder passes up through the tubular valve T, and enters the top of the second cylinder while the steam from the top of the first cylinder descends between the tubular valve T, and the valve-box V, and enters the bottom of the second cylinder. The motion of the valves L, M, P, R, is at the same time changed by the eccentrics shifting their positions on the shaft, as already mentioned. In fig. 6 it will be seen that steam is entering below both pistons, which are consequently both ascending as shown by the arrows. The motion of the crank shaft will thus be in the opposite direction to that indicated by the arrows in fig. 5.

*Claim.*—The inventor does not confine himself to the particular construction or arrangement of valves shown, as the same may be varied, and the valves may be driven by cams or otherwise, instead of by eccentrics. But what he claims is: the constructing steam-engines with two cylinders whose pistons are in connection with two cranks placed at right angles to each other, or which are otherwise so arranged that when one piston is at the end of its stroke, the other piston may be at or near to the middle of its stroke; such cylinders being provided with valves and valve gear so arranged as that the first cylinder may be about half-filled with steam, and that a communication may then be opened between that end of the first cylinder, so filled with steam and the second cylinder, such communication remaining open during or nearly unto the end of the stroke of the second piston, and until the first piston has made one-half or thereabouts of its return stroke, when the steam which has thus been expanded is discharged into the atmosphere or into the condenser.

## METROPOLITAN WATER COMPANIES' REPORTS.

These reports show the progress made by the several water companies, up to the latter end of April last, in the preparations for complying with the Metropolitan Water Act (15 and 16 Vic., cap. 84), which provided that no water shall be taken from any part of the Thames below Teddington Lock.

### *New River Company.*

This report states that no part of the supply furnished to the metropolis by this company has for many years been taken from the river Thames, but the whole is taken from the river Lea, or from chalk springs upon the course of the New River between London and Hertford. Since the passing of the Act works have been undertaken for the diversion of the sewage of the town of Hertford, so as to guard against its pollution.

Two of the contracts for covering the reservoirs at the New River Head, Highgate, and Maiden Lane, are executed between the company and the contractors; the work of the third cannot be executed until the other two are in action, so as to dispense for the period of construction with its use; but the whole will be finished before the period named in the Act, the 31st Agust 1855.

With regard to the arrangements for filtering, the contracts for the filtering beds have been executed; and the filtering will be in efficient operation before the period named in the Act, the 31st December 1855.

Contracts have been also executed for carrying out the system of constant supply and high service.

The expense entailed by the provisions of the Metropolitan Act will be very much greater than was anticipated, and the outlay of 400,000*l.* provided for by the Act of 1852, will not be sufficient; but 300,000*l.* more will be necessary, making a total of 700,000*l.*

### *Grand Junction Waterworks Company.*

This company obtained a Special Act enabling them to comply with its provisions. Under the powers of that Act they purchased land in the parish of Hampton as a site for the works necessary to draw water from that part of the stream of the Thames prescribed by the General Act, and took immediate steps for the execution of such works, and for bringing the water thus procured to their existing works at Kew Bridge. For this purpose they entered into the following contracts:—For the supply of 13,000 yards of 33-inch pipes from the Iron works at Middlesborough, in Yorkshire—For laying the 33-inch main from Hampton to the works at Kew-bridge.—For two engines and six boilers at Hampton, from the Hayle Foundry, Cornwall.—For construction of engine and boiler-houses, reservoirs, &c. at Hampton.—For the construction of one depositing reservoir and two filter beds at Kew-bridge. Up to this time the progress made in the execution of the several contracts is as follows:—5570 yards of the trunk main have been laid. The works at Hampton are in a forward state, the more important portions of the engine and boiler houses having been completed, and the two subsiding reservoirs about two-thirds finished. Of two additional filter beds at the Kew-bridge works, one is completely, and the other nearly finished. There is also a new subsiding reservoir at the Kew works almost completed.

The water delivered daily by the Grand Junction Waterworks Company for seven days in the week, agreeably to the average of the last twelve months, amounts to 5,518,342 imperial gallons. The number of houses in the district is 16,417. Deducting the supplies for baths, railways, road watering, and flushing sewers, the mean quantity delivered per house would amount to 303 imperial gallons per diem. The company will have the power, when their works shall be completed, of increasing their supply in any degree required, as the engine power at Hampton and the trunk main are capable of delivering 20,000,000 imperial gallons per diem.

The site selected for the source of supply is above the village of

Hampton, six miles above Teddington Lock, and one and a half mile above Hampton Lock.

*West Middlesex Waterworks Company.*

This Company procured a special act to enable them to obtain a supply of water from the Thames at Hampton, nearly six miles above Teddington Lock; where they have purchased the freehold land requisite for the construction of their new works, and have entered into contracts for the engines, engine house, and mains necessary to convey the water from this source to their present large subsiding reservoirs at Barnes.

These works are in a very forward state:—The engines are being made; the engine house is in course of erection; and nearly five miles of their 36-inch main (out of eight and a half miles) have been already laid. The directors therefore fully expect that their district will be supplied with water taken from the Thames at Hampton in the early part of next year, which will be considerably within the time allowed by the Metropolis Water Act of 1852.

Contracts have been entered into for the construction of three filter beds at Barnes, in addition to the present subsiding reservoirs. Two of these filter beds are already completed, and the third is nearly so; by which the directors will be enabled immediately to deliver filtered water from their present source of supply, which is about one and a quarter mile above Hammersmith-bridge. The sum of 74,761*l.* has been already paid the contractors on account of the new works.

*East London Waterworks Company.*

This Company state that the whole of the works undertaken by them, in accordance with the requirements of the Act, are in such a state of forwardness, that previously to the period fixed for completion, the Works will be finished, and in operation.

*Southwark and Vauxhall Waterworks Company.*

By the special act this company obtained powers to raise additional capital, to purchase land in the parish of Hampton, and to execute the works necessary to bring water from the new site to their works at Battersea. With a view to the immediate execution of such works, the following contracts were entered into:—With Messrs. Bolckow and Vaughan, of Middlesborough, Yorkshire, for the supply of 23,000 yards (about 11,000 tons) of iron pipes of 36 inches diameter.—With Messrs. Harvey and West, of Hayle, Cornwall, for the construction of an additional engine at Battersea and two lifting engines, with six boilers, at Hampton.—With Mr. John Aird, for laying the 36-inch main, including the passing under the Thames at Richmond, and likewise for the erection of engine and boiler houses, and the formation of reservoirs at Hampton.—With the same contractor, for the formation of the new filter bed and other works at Battersea. —The term fixed in the contracts, as well for the execution of the works as the supply of mains and engines, was the 29th September 1854.

The progress actually made to the present time is as follows:— The works at Hampton, consisting of engine and boiler houses and two subsiding reservoirs communicating by a culvert with the Thames, are about two-thirds finished; but in the portion completed all the heaviest work of the engine and boiler houses, consisting of the foundations and substructions for receiving the engines and boilers, is comprehended. Nine thousand yards of the great main have been laid; the crossing the Thames—a work of great difficulty—is all but accomplished, and in a very satisfactory manner. The pipes are laid on a solid bed of blue clay, and sufficiently beneath the bed of the stream to be quite safe from accidental disturbance. The new engine at Battersea will be erected and ready for work in a few weeks. The intended addition to the boiler houses (almost doubling the former boiler power) is complete. The new filtering reservoir at Battersea is completed and at work.

The water delivered daily by the Southwark and Vauxhall Company to their district may be taken at 8,000,000 gallons. The number of houses in the district is 40,296. The quantity served to each house (the supplies for trades, railways, road watering, and flushing sewers being deducted) is on the average 173 gallons, and the registrar's returns showing that about 6½ souls may probably be the mean number of occupants of houses in the company's district, twenty-six and and a half gallons per diem are given per head of the population.

The new works will, however, afford the means of more than doubling even this supply. The 36-inch main, with the engine power provided at Hampton, will deliver at Battersea 20,000,000 gallons in the twenty-four hours. The company's works at Battersea and Hampton occupy twenty-seven acres; the net area of the four subsiding reservoirs is 349,500 superficial feet; of the three filtering reservoirs 200,000 superficial feet. The area of filtration, it may be remarked, is more than would be required for a much larger supply than the company now gives. The site selected for the source of supply is above both Hampton Court and Hampton village, nearly six miles above Teddington and one and a half mile above Hampton Lock.

The distributing apparatus of the company consists of upwards of 420 miles of mains, varying in size from three inches to twenty-seven inches diameter, but the pipes are in constant process of extension, almost daily applications for that purpose being made to the company. Wandsworth and Putney have recently had mains and services laid down at the requisition both of the parochial authorities and the inhabitants of those villages.

*Lambeth Waterworks Company.*

This company has completed the construction of entire new works at Seething Wells, above Kingston-on-Thames, and removed the old works. Such new works have long since been brought into full and satisfactory operation and the old works wholly abandoned, so that this company's district is now entirely supplied according to the Act.

*Chelsea Waterworks Company.*

The requirements of the Act have compelled this company to provide for the construction of entire new works at Seething Wells, above Kingston-on-Thames, prior to the abandonment of the old works at Chelsea, it therefore became necessary for the company to acquire possession of a new site for their pumping station, of a line of way for the aqueduct or main pipes from Seething Wells to Chelsea more direct in several places than the existing public roads, and of lands on Putney Heath for the construction of large covered reservoirs. Considerable difficulties have presented themselves in connection with the purchase of the various properties required by the company; but in the autumn of 1853 they succeeded in obtaining possession of the necessary sites, and have since been proceeding with the erection of the requisite new works, which the court of directors have no doubt will be completed and in operation in the spring of 1856.

*Kent Waterworks Company.*

This company does not take its supply from the Thames, but from the Ravensbourne, a tributary stream to that river. The water is taken above the highest point where the tide flows. Before the passing of the Metropolis Water Act, 1852, the company effectually filtered all water supplied by them for domestic use, and they do so now; and they were then, as they are now, prepared to give a constant supply for the domestic use of the inhabitants of houses supplied by them, subject to the conditions specified. The company have already, therefore, complied with all the requirements of the Act referred to, so far as the same apply to their district.

Since the passing of the Act the company have at great expense purchased additional land, and are constructing upon it additional filtering apparatus, and erecting a new Cornish engine, with the view of enabling them to afford to new tenants in their rapidly increasing district the constant supply of filtered water contemplated and required by its provisions. These new works are nearly completed, and will be in operation in a very few months.

*Hampstead Waterworks Company.*

This company had commenced a new artesian well in Kentish Town previous to the passing of the Act. The works were undertaken by Messrs. Degoussée and Laurent. The well varying from 9 to 6 feet in diameter, has been carried down 540 feet. From this point the boring was commenced, and has been continued day and night without intermission, since June last. The total depth now reached is 886 feet, and as the boring is now proceeding through the marl, which constitutes the base of the chalk formation, there is every reason to believe that the estimate of Messrs. Degoussée and Laurent as to the thickness of the chalk stratum under London will be completely verified, and the greensand found within 200 feet of the depth now attained.

The steam power necessary for lifting the water to the elevation required for distribution in the company's district has been provided and fixed, and before the expiration of this year an ample supply of water from the new works will be rendered available for the public use.

## NEW PARLIAMENTARY STANDARDS OF LENGTH AND WEIGHT.

In 1841, the Commissioners appointed to consider the steps to be taken for the restoration of the standards of weight and measure, presented their report to both Houses of Parliament: in which they recommended the appointment of a committee of scientific men to superintend the construction of the new parliamentary standards. In accordance with this recommendation a committee was appointed in 1843, consisting of the Astronomer Royal, G. B. Airy, Earl of Rosse, Marquis of Northampton, the Lord Wrottesley, F. Baily, Esq.; J. E. D. Bethune, J. G. S. Lefevre, Esq., Sir J. W. Lubbock, Bart., the Rev. G. Peacock, Dean of Ely, the Rev. R. Sheepshanks, Sir J. F. W. Herschel, Bart., and Professor Miller.

This committee presented their report in March 1854, in which they have fully discussed the most expedient methods and materials for constructing the various standards, and also in consideration of the inadequacy of the present arrangements to maintain the national standards in a state fit for the public wants, as regards either the sufficiency of number of the Exchequer standards, or the state of preservation of those standards, or the nature of the comparing apparatus and the methods used in their applications, or the provincial dissemination of copies of the standards, or the inspection and occasional comparison of all for the purpose of insuring their accuracy; the committee recommend the appointment of a permanent scientific officer: whose business it shall be to keep a constant watch on the state of the primary standards, the secondary Exchequer standards, the local standards, the equipments of the standard offices, the relations of British and foreign standards, and the state of the law generally as applying to standards; and to memorialise the government from time to time, as the occasion may arise, on any of these points.

This recommendation was proposed in Lord Carysfort's Bill, which suggested that four commissioners should be appointed, with an establishment of eight clerks and a sufficient number of workmen; and although their duties as described do not *totidem verbis* include the employments stated above, yet it is plain that an establishment of this liberal character was intended to maintain the standard department in a perfectly efficient and reputable state. This Bill, however, never passed into law, the appointments never were made, and the management of the standards has fallen entirely into the hands of subordinate officers of the Exchequer.

The committee held its first meeting in 1843, when it appeared that the construction of the standard of length had been undertaken by Mr. F. Baily; and that of weight by Professor W. H. Miller; but, on the death of the former gentleman, his task was entrusted to the Rev. R. Sheepshanks. The committee had access, for purposes of comparison, to the length, scales, and weights belonging to the Ordnance and several royal societies, which had been compared with the lost imperial yard standard, and the lost imperial troy pound. They decided to continue the adoption of one yard as the length of the parliamentary standard.

The following are the Length-scales which had been compared with the lost Imperial Yard Standard:—Two three-feet iron bars belonging to the department of the Ordnance Survey; Shuckburgh's scale, in the possession of the Royal Society; the brass scale of the Royal Society, No. 46; and the brass tubular scale of the Royal Astronomical Society.

The following are the Weights which had been compared with the lost Imperial Troy Pound standard:—The brass Troy pound of the Exchequer Office; the brass Troy pounds from the cities of London, Edinburgh, and Dublin; the platinum Troy pound and the two brass Troy pounds then in the custody of Professor Schumacher; and the platinum Troy pound of the Royal Society, No. 48.

The committee also had access to the following length-scales and weights:—The ruined Imperial Yard Standard (in custody of the Speaker of the House of Commons); Troughton's five-feet scale (presented by W. Simms, Esq., and now preserved at the Royal Observatory, Greenwich); Ramsden's twenty-feet bar, and Roy's three-feet bar (purchased by the committee, and now deposited at the Royal Observatory, Greenwich); two troy pounds, formerly in the possession of Mr. Bingley; the troy pound used by the late Mr. Robinson of Devonshire-street, Portland-place; and the troy pound formerly belonging to Mr. Freeman (now the property of Messrs. Vandome and Titford).

### *Construction of the Standard of Length.*

The first important question which presented itself to the committee, was, whether the measure of length should be defined by the whole length of a bar, or by the distance between two points or lines marked on it.

The most celebrated of the standards constructed in modern times is the new Prussian standard, made by the late astronomer, Bessel. In this standard, the whole length of the bar is adopted as the measure of length. The reasons which induced Bessel to substitute a standard of this construction (or standard *à bouts*) for the standard in which the measure is defined by the distance between points or lines upon its surface (or standard *à traits*), which was the principle of construction of the former Prussian standard, were first, that if a flexible bar be supported on two points, the extreme length of the bar from the centre of one end to the centre of the other end is not sensibly altered by its flexure, but the distance between two points or lines upon the upper surface may be considerably altered. Bessel has himself, however, remarked that this objection to line-measure is removed if the lines be engraved on surfaces which are depressed to the middle of the thickness of the bar (a principle long since employed in English standard bars); and, moreover, the tendency to alter the apparent length, whether at the surface or the middle of the thickness, may be destroyed by proper adjustment of the points of support, and perhaps still more surely by supporting the bar at numerous points by lever-frames which will insure equal supporting forces at all the points, or in special experiments by floating the bar in quicksilver. A second reason assigned by Bessel is, that the principle of end-measure is more convenient than the line-measure for the production (that is, practically, the comparison,) of copies of the standard. It appears probable that this remark is well founded, as regards the construction of secondary standards for commercial purposes, but it is doubtful whether it applies to secondary standards for scientific purposes, and it can scarcely apply to primary standards, in regard to which the consideration of convenience (in the few comparisons that may be made at intervals of many years) has no weight, when contrasted with the consideration of conservation of the standard length. Another reason is, that it is more convenient for use; but the members of the committee, who have witnessed the operation of measuring a geodetic base by means of bars carrying the line-measure, have been led to form a high estimate of the convenience of the line-principle in that instance. It would appear, too, that in Captain Kater's measurement of the pendulum, and Mr. Baily's comparison of the mètre *à traits* with the yard, no inconvenience from that cause was found by either observer. It is moreover to be remarked, that the whole of the British geodetic bases have been measured by bars constructed on the line-principle; and a standard which is intended to apply advantageously to them must be constructed on the same principle. The end-measure has never, so far as is known to the committee, been applied to any scientific determination in England.

These considerations induced the committee to adopt the line-standard, or measure *à traits*, for the parliamentary standard of length.

The point which next engaged their attention was the material of which the new standard of length should be formed. The requisite qualities are invariability and durability. It was remarked by the committee, with reference to the fusible metals and alloys, that copper is soft, and is not easily cast; that cast brass is considered unsound until it has been hammered; that gun-metal is easily cast, and may be made (by due proportion of its component metals) pretty hard and elastic, and is free from liability to corrosion; and that cast-steel is perfectly manageable; also, that platinum, although it possesses the advantageous properties of being very durable, and little affected by changes of temperature, is inconveniently heavy and soft; but that iron, whether cast or forged, is manageable, and probably invariable. It was considered that the choice of materials was practically limited to the following metals and alloys: Gun metal in proportions of copper, tin, and zinc to be determined by experiment); cast steel; cast iron; and forged iron. These metals all possess the qualities of invariability.

A series of experiments was made by Mr. Baily on gun-metal formed of different proportions of the simple metals. It was found at length that an alloy formed in the following proportions, copper 16, tin 2½, zinc 1, appeared to possess every desirable property. It is hard; it is highly elastic, recovering its form (as to sense) perfectly after every strain, until the weight placed on it is sufficient to break it, when it breaks without bending; it is also strong. Gun metal being also less liable to injury, or even total destruction from rust, the committee determined on adopting it, when composed in the proportions above mentioned, as the material of the standards of length.

The form adopted for the standard of length and for all its copies is that of a solid square bar, 38 inches long and 1 inch square in transverse section. Near to each end a cylindrical hole is sunk (the distance between the centres of the two holes being 36 inches) to the depth of 0·5 inch. At the bottom of this hole is inserted in a smaller hole a gold plug or pin about 0·1 in diameter, and upon the surface of this pin there are cut three fine lines at intervals of about 0·01 inch transverse to the axis of the bar, and two lines at nearly the same interval parallel to the axis of the bar. The measure of length is given by the interval between the middle transversal line at one end and the middle transversal line at the other end; the part of each line which is employed being the point midway between the longitudinal lines. The other transversal lines were used, in the operations of comparison, only for assigning the scales of the micrometers.

The selection of authorities for the reproduction of the imperial standard was a matter of considerable difficulty, arising from the imperfections in and discrepancies between existing standard measures; the scale of the Royal Astronomical Society was proved to have undergone considerable change. This discovery necessarily took away all authority from other scales of a similar construction. From this and other causes, Mr. Sheepshanks determined, first, that no scales ought to be used for restoration of the value of the imperial standard, except those which had been compared *directly* with the imperial standard; secondly, that among these the only admissible scales are, the Royal Society's brass scale No. 46, and the two 3-feet iron bars of the Ordnance Department.

The definition of a length, as represented by a standard bar, requires a statement of the temperature at which the standard bar is to be used. It appears, upon examing the amount of the expansion of a metallic bar for a given change of temperature, that the effect of a change of 0°·01 or 0°·02 Fahr. is sensible in the measure of the length of a bar; and it was therefore necessary to employ methods of ascertaining the temperature which should be certain to that degree of accuracy. No thermometer in England, at the time of commencing these experiments, could be trusted to such a nicety.

In accordance with a recommendation in the report of 1841, Mr Sheepshanks commenced a series of comparisons of Bronze 28 with numerous bars, in order to select from them five bars, which, in respect of the distinctness of the engraving, their floating evenly in quicksilver, and their near approach to the length of the lost imperial standard, might seem well adapted to be taken as parliamentary standards, and copied. It was discovered during these observations that there was a difference between the comparisons of different observers far exceeding the uncertainty inferred by the theory of probable errors from the observations of each observer taken separately.

The expansions of these bars corresponding to a given change of temperature had been sufficiently determined in the course of the experiments; and it was then judged expedient, instead of stating the difference in the length of the selected bars at the same temperature, to infer the difference of temperature which would cause all to represent the same length, by the application of which it would be possible to assign the specific temperature at which each bar represents precisely the length of one yard. Thus it was found that the length of one yard as given by the lost imperial standard is represented with no sensible uncertainty, except in the measures of the imperial standard itself, by the following bars, at the temperatures placed opposite to them:—

| | |
|---|---|
| Bronze 19 or No. 1 at 62·00 Fah. | Bronze 7 or No. 4 at 61·98 Fah. |
| Bronze 20 or No. 2 at 61·94 „ | Bronze 10 or No. 5 at 62·16 „ |
| Bronze 2 or No. 3 at 62·10 „ | Bronze 28 or No. 6 at 62·00 „ |

The degrees of temperature for the use of these standards are defined as proportional to the corresponding apparent increase of volume of quicksilver in the thermometer tube; the degree 32° representing the freezing-point of water; and the degree 212° representing the temperature of steam under Laplace's standard atmospheric pressure, or the atmospheric pressure corresponding to the following number of inches in the barometric reading reduced to 32° Fahr. 29·9218 + 0·0766 × cosine (2 latitude) + 0·00000179 × height in feet above the sea; and the degree 62° denoting the temperature which produces in the quicksilver an apparent expansion equal to $\frac{30}{180}$ of the expansion between 32° and 212°; and so in proportion for other degrees.

The committee proposed that the bar No 1 be adopted by the legislature as the Parliamentary Standard of One Yard; that Nos. 2, 3, 4, 5, be adopted as parliamentary copies; and that No. 6 be retained by some officer of the government for the comparison of other bars, or for other scientific purposes in which reference to the standard may soon be required.

*Construction of the Standard of Weight.*

In the construction of the standard of weight, the committee decided on employing platinum as the metal least susceptible of injury from oxidation or other chemical action, or from heat, and as least liable to uncertainty in the results of weighings, on account of its great specific gravity.

The form recommended by Professor Miller, and adopted by the committee, is that of a cylinder nearly 1·35 inch in height and 1·15 inch in diameter, with a groove or channel round it whose middle is about 0·34 inch below the top of the cylinder, for insertion of the points of the ivory fork by which it is to be lifted. The edges are carefully rounded off.

For the comparison of weights, Professor Miller procured from Mr. Barrow a balance of the utmost delicacy. This instrument was mounted in a cellar beneath the Mineralogical Museum at Cambridge, and there all the operations of weighing the representatives of the lost standard, the new primary standard, and the copy of the French standard were performed.

It was decided that the weight of the new standard should be adjusted to correspond (in the proper proportion) to that of the old troy standard, on the supposition that both are weighed in vacuo. This understanding is the same which had been adopted by Professor Schumacher and other accurate observers. In order to carry it out fully, it became necessary to decide on the specific gravity of the lost troy standard. Upon this element there is some uncertainty. The specific gravity of Vandome's pound at 18° centigrade was found, by weighing in water, to be 8·1505; and this was adopted by Professor Miller as the probable specific gravity of the lost pound, inasmuch as the form of this pound appeared to be very similar to that of the lost standard, as represented in drawings. The specific gravities of Mr. Bingley's pounds were found by the stereometer to be 8·427, 8·358. That of Alchorne's pound (supposed to be the same as Mr. Bingley's second pound), as ascertained by weighing in water, appears to be nearly 8·375. The lost troy pound was described in Lord Carysfort's proposed bill as a piece of "fine copper." The specific gravity of the lost troy pound in that case was about 8·895. No other standard weight, however, has been found in this or in any other country, whose specific gravity approaches to this value. At the same time, the doubt as to the specific gravity of the lost standard leaves no uncertainty whatever on its weight when the weighings are performed in air, or on what may be called the commercial weight of the lost standard.

A repetition of the comparisons of the eight troy pounds, which had been compared with the lost troy standard, among themselves of the pounds in each group left no doubt that the brass pounds had gained in weight, while the platinum pounds retained precisely the same relation as before. There appeared to be no doubt that the increase of weight of the brass pounds arose from oxidation. Professor Miller therefore decided to base his restoration of the standard pound on the platinum pounds only. A troy pound was accordingly prepared, by the use of these platinum pounds, representing (with a very small assigned error) the weight of the lost standard in air.

In the report of 1841, Article 25, it was recommended that the future standard of weight should be the avoirdupois pound or pound weight of 7000 grains. The following auxiliary weights were therefore prepared by Professor Miller:—4 of 1240 grains each (nearly); 1 of 800 grains; 1 of 440 grains; 1 of 360 grains; 4 of 80 grains; 2 of 40 grains.

These weights were so chosen that the larger weights can be compared with combinations of the smaller (thus 80 grains may be compared with twice 40, 360 with four times 80 and one 40, and so on), and that the weight of 5760 grains can be compared with four of 1240 and one of 800, and that of 7000 grains with 5760 and one of 1240.

Expressing the error in the 40-grain weight by an algebraical symbol, the error of every weight in this series is determined from comparisons of the weights, and is expressed by two terms, of which one is numerical, and the other is a mutiple of that symbol; and the error of $4 \times 1240 + 800$ is also expressible by a numerical term and a different multiple of the same symbol. These weights being compared with the troy pound of 5670 grains, the value of the symbol was obtained, and therefore the error of any of the 1240 grain weights was known; and then a pound of 7000 grains was formed by adding the troy pound and a weight of 1240 grains.

Five platinum pounds were thus prepared by Professor Miller, marked respectively, P S 1844 1 lb., No. 1 P C 1844 1 lb., No. 2 P C 1844 1 lb., No. 3 P C 1844 1 lb., No. 4 P C 1844 1 lb., the specific gravities of which were found to be as follows:—

| | |
|---|---|
| P S | 21·15702 |
| No. 1 P C | 21·16634 |
| No. 2 P C | 21·16334 |
| No. 3 P C | 21·16128 |
| No. 4 P C | 21·15549 |

Comparing P S with the representative of the troy pound in the manner just described, it was found that in air of the temperature 65°·66 Fah., under the pressure of 29·750 inches of mercury (these being the means of the temperatures and pressures at which Von Nehus compared the ancient troy standard with the two platinum pounds),

$$\text{P S} = 0{\cdot}6341 \text{ grain} + \frac{7000}{5760} \times \text{lost standard},$$

and this may be considered as the commercial weight of P S.

Assuming the specific gravity of the lost standard to be the same as that of Vandome, and that P S and the lost standard are compared in vacuo, P S = 7000·000238 grains, of which the lost standard contained 5760. This may be considered as the philosophical weight of P S. Also,

| | |
|---|---|
| No. 1 P C = P S + 0·00052 grs. | No. 3 P C = P S — 0·00178 grs. |
| No. 2 P C = P S — 0·00088 grs. | No. 4 P C P S — 0·00314 grs. |

The committee recommends that P S be adopted as the Parliamentary Standard of One Pound, and that No. 1 P C, No. 2 P C, No. 3 P C, No. 4 P C, be adopted as parliamentary copies.

In conformity with the recommendation of the committee, the parliamentary standards of one yard and one pound have been deposited in the office of the Exchequer. The copy of length standard, No. 2, and the copy of weight standard, P C, No. 1, in the Royal Mint. The copy of length standard, No. 3, and the copy of weight standard, P C, No. 2, have been transferred to the Royal Society. The copy of length standard No. 5, and the copy of weight standard, P C, No. 3, are deposited in the Royal Observatory of Greenwich. The copy of length standard, No. 4, and the copy of weight standard, P C No. 4, are immured in the sill of the recess on the east side of the Lower Waiting Hall in the New Palace at Westminster.

The only comparisons of the British standard weights with foreign standards have been made with the French Kilogrammes des Archives; in comparing which with our standard pound weight, it appeared that the weight was by direct comparison, 15432·3482; by indirect comparison, 15432·3488.

The committee would not recommend the reference of the values of the measure and weight represented by the standards to natural elements; but consider the ascertaining of the earth's dimensions and of the length of the seconds' pendulum in terms of the standard of length, and of the weight of a certain volume of water in terms of the standard of weight, as philosophical determinations of the highest importance.

The committee in addition to the standards *à traits*, purpose constructing a standard *à bouts*, equivalent in length to the parliamentary standard *à traits*. It is to be formed of steel, with ends of hardened steel, or hard stone, as quartz or sapphire, or some sufficiently hard and incorrodible material. The end surfaces to be curved, forming portions of one sphere whose centre is the centre of the bar. They further recommend that copies of the standard should be deposited in each of the British Islands, the principal British dependencies, and most foreign countries.

Respecting the scale of multiples and subdivisions proceeding from the values of the primary standards, and the decimal scale, the committee adopts to the utmost extent the recommendations contained in the report of 1841, tending to alter the linear measures of the chain and the mile, to diminish the confusion between avoirdupois weight and troy weight, and to banish the stone of 14 lb. and the hundredweight of 112 lb. Stating that at the present time the facilities are great for introducing the decimal scale of coinage, weights, measures, and length.

The Bank of England has spontaneously adopted a decimal scale of multiples and subdivisions of the troy ounce for weighing gold and silver,—which has been followed by the Royal Mint, and by bullion dealers in general, and which has been sanctioned by parliament.

In the Custom House of London it has also been found necessary to adopt a series of weights in the millesimal scale of subdivision of the avoirdupois pound, in order to facilitate the calculations of tare upon ribbons and other goods in numerous small packages, upon which duty is payable on the net weight only.

Remarking that a decimal scale ascending from the pound weight is called for on one side, and a decimal scale descending from it is required on another side, and that thus an entire decimal scale based on the pound weight may be considered as likely to be soon established; remarking also that the decimal subdivisions of the pound weight, down to the one-thousandth part, are expressed by integral grains; and conceiving that the co-existence of two decimal systems (based one on the pound weight, and the other on the troy ounce) offers very great facility for the abrogation of one, and the complete introduction of the other; the committee considers that there is now a prospect of attaining the long-desired simplification of the British system of weights, by the entire suppression of troy weight; and for this reason (in addition to those founded on the extreme convenience of a decimal scale in any special system of weights) it is desirous that every facility should be given to the introduction of the decimal scale based on the pound weight.

On these several considerations the committee recommends that the following secondary standards of length be lodged in the office of Exchequer, for public reference:

- A mural standard of 100 feet.
- A mural standard of 22 yards, or the land chain.
- A mural standard of 20 yards.
- A mural standard of 10 feet.
  (The best form for each of these will probably be, two steel projections inserted in a wall, and defining the required length by the interval between the inner faces).
- A standard *à traits* of one yard, extended to 40 inches, and divided into inches; with a microscopic apparatus for comparisons.
- A standard *à traits* of one foot, decimally divided; with similar apparatus.
- A standard *à bouts* of one yard, with a multiplying-lever-apparatus for comparisons.
- A standard *à bouts* of five links or 1·1 yard.
- Standards *à bouts* of two feet, of one foot, of 0·5 foot or six inches, and of 0·25 foot or three inches, with similar apparatus for comparisons.
- A standard *à bouts* of the French mètre.
- A standard *à bouts* of the Prussian yard.

Also, that the following secondary standards of weight be lodged in the Exchequer, in addition to those which are now in that office, for public reference:—

- 100 lb., 200 lb., (if judged necessary).
- 10, 20, 30, 40, 50 lb.
- 1, 2, 3, 4, 5 lbs.
- ·1, ·2, ·3, ·4, ·5 lb.
- ·01, ·02, ·03, ·04, ·05 lb.
- ·001, ·002, ·003, ·004, ·005 lb.
- 100, 200, 300, 400, 500, 1000 grains.
- 10, 20, 30, 40, 50 grains.
- 1, 2, 3, 4, 5, 6, 7 grains.
- Small decimal subdivisions of the grain, for verification of the balances.
- 100, 200, 300, 400, 500 ounces troy.
- 10, 20, 30, 40, 50 ounces.
- 1, 2, 3, 4, 5 ounces.
- ·1, ·2, ·3, ·4, ·5 ounce
- ·01, ·02, ·03, ·04, ·05 ounce.
- ·001, ·002, ·003, ·004, ·005 ounce.
- A copy of the French kilogramme.

Professor Miller has already taken steps for preparing the 10 lb. weight, the various troy weights, and the kilogramme.

In regard to standards of capacity, the committee see no necessity for departing from the recommendations of the report of 1841, which would provide standards of 9 gallons, 5 gallons, 3 gallons, quart, $\frac{1}{2}$ gallon, pint, in a conical form; and bushel, $\frac{1}{2}$ bushel, peck, gallon, $\frac{1}{2}$ gallon, quart, pint, $\frac{1}{2}$ pint, gill, $\frac{1}{2}$ gill, in a cylindrical form.

## PRICE'S PATENT CANDLE COMPANY'S WORKS, BROMBRO', CHESHIRE.

THE new candle manufactory is situate on the left bank or the Eastham side of the pool, fronting the Mersey, the water of which has been allowed to flow in its wonted course alongside the works, and under the bridge on the Chester road. An excellent view of the proportions of this huge manufactory may be seen from the steamer on its passage to Eastham. The building, which in itself covers an extensive area of ground, is constructed of brick, and is formed into large divisions, to carry on the various processes connected with candle making. It has no fewer than thirteen segment-shaped roofs, made of corrugated iron, and painted white. All these roofs are nearly finished, and some hundreds of men are now employed in the different departments, hurrying on the works to completion. An enormous tank has been formed immediately at the rear of the candle works, with warehouses underneath, and adjoining there are weaving sheds and other appurtenances. A range of offices is now building. A strong wooden wharf, supported by piles, on which there are three cranes, has been also constructed at the back of the manufactory, alongside which small vessels may load and discharge their cargoes. The company will manufacture their own gas for the use of the works, and will also extend it to the cottages of their workpeople, at some distance from the manufactory. In fact, the whole concern betokens an undertaking replete in every convenience and improvement which science, wealth, and labour can introduce. On the elevated ground to the south of the manufactory, 32 neat and comfortable cottages, for the workpeople and their families, have been erected, and are all occupied. These houses have been built in blocks of four, and each has an allotment of ground for a comfortable garden. The foundations for 16 more houses are now being excavated, and their erection will be immediately proceeded with by Mr. Allport, of Bootle, who is the contractor. These cottages are very pleasantly situate, having extensive views of the river and of the picturesque scenery on both sides of the Mersey. Upon the completion of the factory, the number of these cottages will be increased to 200, all of which will be supplied with water and gas from the main works at the pool. Quantities of piping are strewed about the ground, showing that, in addition to a supply of water and gas, the health of the inmates will be attended to by having their habitations efficiently drained. A large plot of land has been appropriated to brickmaking and brickburning, and a great number of persons are employed in converting the clayey soil of that locality into material for the erection of houses. We hear that it is the intention of this spirited company to erect a number of villa residences on their land immediately fronting the Mersey, and also to form a promenade close to the river, similar to the one at Rock Ferry.

## EDUCATIONAL EXHIBITION.

IT is reported that the applications from intending exhibitors for space are very numerous, and that 1200 square feet of horizontal space, and upwards of 32,000 feet of wall space had been asked for, being about four times the space at the disposal of the committee. That these applications were irrespective of the space required for the foreign exhibitors. All the leading educational societies and educational establishments would exhibit, and information had been received that articles were coming from France, Holland, Belgium, Sweden, Denmark, Holstein, Hanover, Seven Cantons of Switzerland, and the United States of America; sent by the respective governments of those countries, as well as from private individuals. From Canada, New Brunswick, and Malta, articles have already arrived. The State of Connecticut, the governments of Denmark and Sweden have respectively appointed the Hon. H. Barnard and Messrs. Fogh and Siljeström as their representatives at the Exhibition: the two former gentlemen have already arrived. All foreign articles intended for exhibition are to be admitted duty free, arrangements have been entered into with Messrs. Cubitt and Company, for fitting up St. Martin's Hall for the reception of the goods. Dr. Whewell, master of Trinity College, Cambridge, has undertaken to deliver the inaugural lecture, "On the Material Helps of Education," on the 10th July, at three o'clock, to be followed by a series of seven lectures, "On the Sequence of the Sciences," by Professors De Morgan, Playfair, Forbes, Huxley, Henfrey, Dr. R. G. Latham, and Professor Creasy. Numerous other lectures on subjects connected with schools and education will be given by eminent men while the Exhibition is open.

The Exhibition is to be opened with a conversazione, on the evening of the 4th July, at which H.R.H. the President had intimated his intention of being present; a private view will take place on the 5th, and the Exhibition will be open to the public daily, on and after the 6th.

It is calculated that the total expenses of the Educational Exhibition, with the accompanying Lectures, Conversazioni, Conferences, &c., if it receive the full development which its great importance requires, will not be less than 2500*l*.

## IRON CHURCHES FOR AUSTRALIA.

Two iron churches in the building yard of Robertson and Lister, Glasgow, are now completed. They are similar in size and general appearance, with the exception that one has two spires, one on each side, and the other one spire, springing from the centre of the pediment. The chief feature of the front elevation is an arcade of ornamental columns and arches, standing out in bold relief, supporting a pediment, and flanked at the side by massive towers, in which are placed the stairs leading to the galleries. The lower series of columns is roofed by a balcony, forming an open porch, whence access is had to the church and to the stairs of the galleries. The dimensions of each church are 73 feet in length, and 45 feet in breadth. The interior is lighted on each side by a series of circular-headed windows, each 20 feet in length: and at the back by two large stained-glass windows. The vaulted ceiling, supported on cast-iron arched girders springing from iron columns, rises to the height of 40 feet. In the crown of the arched ceiling will be placed iron or zinc perforated gratings, for the ventilation. The external roofing is formed of corrugated iron.

## NOTES OF THE MONTH.

*Erratum.*—In the description of Milner's Steam-Engines, we have omitted the figure in which the parts referred to by the letters from C to J inclusive were indicated, they being neither new nor necessary to explain the invention.

*British Association for the Advancement of Science.*—The next meeting is fixed for Wednesday, September 20th, at Liverpool, under the presidency of Lord Harrowby.

*Archæological Institute.*—The annual meeting of this Society takes place at Cambridge, on Tuesday, July 4th. The annual meeting of members and meeting for reading memoirs will be on the 11th.

*Geological Society.*—At the general meeting held at Somerset House on the 24th May, M. W. J. Hamilton was unanimously elected President, Professor Forbes having resigned in consequence of his appointment to the Chair of Natural History at Edinburgh.

*Architect to Ecclesiastical Commissioners, Ireland.*—Mr. Alexander Hardy, of Armagh, has been appointed architect under this Commission.

## NEW PATENTS.

### PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAW AMENDMENT ACT.

*Dated February* 20, 1854.

406. W. Melville, Lochwinnoch, Renfrew—Improvements in printing textile fabrics and other surfaces

*Dated February* 24.

450. W. Macnab, Greenock, Renfrew—Improvements in steam-engines of the class usually termed trunk engines

*Dated March* 1.

500. S. Roussel, Rue Caumartin, Paris—New system of painting and colouring glass, being an imitation of old and new church window-glasses, called "Typophanic"

*Dated March* 6.

536. A. Barclay, Kilmarnock, Ayr—Improvements in condensing steam-engines

*Dated March* 8.

554. L. J. Barnetche, Bordeaux, France—Improvements applicable to the prevention of accidents on railways

*Dated March* 9.

562. J. Smith, Liverpool—Improvements in baking-ovens

*Dated March* 17.

638. T. J. Herapath, Bristol—Improvements in the manufacture of manure from sewage, which are also applicable to other artificial manures

*Dated March 20.*

658. C. A. B. Chenot, Paris—Improvements in the manufacture of steel, iron, and different alloys, cast, welded, and moulded

*Dated March 23.*

686. M. Poole, Avenue-road, Regent's-park—Improvements in preventing alterations of bank-notes, cheques, and other documents. (A communication)

*Dated March 27.*

710. G. Collier, Halifax, York—Improvements in looms for weaving terry and cut pile fabrics

*Dated March 29.*

724. F. W. Harrison and H. G. W. Wagstaff, Pollard's-row, Bethnal-green—Improvement in the construction of wicks for candles

*Dated April 1.*

748. A. E. L. Bellford, Castle-street, Holborn—Improvements in breech-loading fire-arms. (A communication)

*Dated April 5.*

782. J. Howden, Glasgow—Improvements in the manufacture of rivets, bolts, spikes, screw-blanks, and similar articles

*Dated April 8.*

827. J. Platt, Oldham, Lancaster—Improvements in machinery for preparing cotton

*Dated April 11.*

846. J. Childs, Belmont, Vauxhall—Improvement in subjecting fatty and oily matters, and matter containing oils or fats, to pressure

850. T. S. Whitworth, Salford, Lancaster—Improvements in the mule for spinning and doubling cotton and other fibrous materials

*Dated April 18.*

892. J. Rowley, Camberwell—Improvements in the manufacture of a material as a substitute for leather

*Dated April 29.*

969. C. Kingsford, Buckingham-street, Strand—Improvements in solidifying or indurating peat, soft, small, or pulverised coal, and other substances of a like oleaginous or bituminous nature, and machinery and apparatus for effecting the same

*Dated May 1.*

972. W. A. Waddington, Stonegate, York—Improvements in the construction of sounding-boards for pianofortes and other like stringed instruments

973. W. A. Archbald, Stanhope-street, Gloucester-gate—Improvements in the manufacture of concrete cane-juice, and sugar

*Dated May 2.*

980. W. Hutton, Portland-town, St. John's-wood—Improved machine for the manufacture of bricks

986. R. J. Maryon, York-road, Lambeth—Improvements in the construction of and manufacture of anchors

*Dated May 4.*

998. C. Mee, Bath — Improved foundation for working out ornamental designs or patterns

1000. C. Barlow, Chancery-lane—Improvements in meters for accurately measuring water and other fluids discharged from pipes, sluices, or vessels. (A communication from J. R. Taylor, New York)

1002. J. Manley, Chacewater, Cornwall—Improvement in ventilation, and in treating smoke so as to prevent the ascent of the denser particles thereof into the atmosphere

*Dated May 5.*

1004. W. Exall, Reading, Berks—Improvements in machines for cutting straw and other such materials

1006. E. Haseler, Wolverhampton—Improvement or improvements in ornamenting metals, papier-mache, horn, and shell

1008. A. M. P. Barbette, Paris—Improvements in the manufacture of brass-topped nails

1010. A. Warner, New Broad-street—Improvements in the manufacture of metal sheets for sheathing ships and other vessels, and for other uses

*Dated May 6.*

1020. R. Bulkley, New York—Extinguishment of fires in steamers, vessels, houses, and buildings of all descriptions

1022. J. H. Johnson, Lincoln's-inn-fields—Improvements in the construction of railway carriages. (A communication from A. F. J. Doebs, Toulouse, France)

1024. J. Bernard, Club-chambers, Regent-street—Improvements in machinery or apparatus for sewing, stitching, or ornamenting

*Dated May 8.*

1026. C. Pfersdorff, South-row, Kensall New Town—New toy or aeriel top

1028. G. F. Logan, Glasgow—Improvements in templates to be used in constructing iron ships, boats, boilers, and other metallic structures

1030. G. Thomas, Osnaburgh-street, Regent's-park—Improvements in the construction of the framework of upright pianofortes

1032. C. B. Normand, Havre, France—Improved machinery for sawing wood

*Dated May 9.*

1034. F. P. Berques, Richmond-road, Dalston—Improvements in cooking and heating stoves, and in generating heat therefor

1036. C. Liddell, Abingdon-street, Westminster—Improvements in the permanent way of railways

1038. E. N. Horsford, Massachusetts, U. S.—Removal of chlorine from substances and fabrics

*Dated May 10.*

1040. P. A. Sparre, Salisbury-street, Strand—Improved mode of preventing the alteration or falsification of written documents

1042. R. Reece, Athy—Smelting of iron by means of turf or peat simultaneously with the combustion of the peat and collection of the products therefrom

1044. J. Anthony and W. T. Chafe, Devonport—Improvement in machinery for the manufacture of pipes and tubes from lead and other soft metals and alloys

*Dated May 11.*

1047. R. Miles, Stoke Hammond, Bucks—Improved coupling joint or connection for tubing or other purposes

1048. E. Brown, Sheffield—Improvements in the manufacture of scissors from steel and other metals

1050. J. Cundy, Carrington, Nottingham—Improved reflector globe or shade for gas candle, oil, and other artificial light

1051. W. Delarue, Bunhill-row—Improvements in distillation

1052. H. Doulton, High-street, Lambeth—Improvements in kilns used in the manufacture of stoneware, earthenware, and china

1053. A. V. Newton, Chancery-lane—Improvement in the construction of carriage-wheels, and in the mode of mounting them on their axles. (A communication)

1054. E. W. Abbott, Regent's Quadrant—Improvements applicable to the manufacture of umbrellas and parasols, and cases for containing the same

*Dated May 12.*

1055. J. Platt, Oldham, Lancaster—Improvements in apparatus or machines for forging, drawing, moulding, or forming spindles, rollers, bolts, and various other articles in metal

1056. J. Penton and J. Mackay, Chipenham, Wiltshire—Improvements in the construction of railway wheels and tyres

1057. W. Waite, Gloucester-street, Regent's-park—Improvement applicable to the construction of sewers, drains, and pipes, for the conveyance of sewage, water, or gas

1058. C. N. Nixon, Ramsgate, Kent—Improved modes of attaching rudders to floating vessels

1059. D. Campbell and J. Barlow, Accrington, Lancaster—Improvements in looms for weaving

1060. T. L. Holt, Warwick-square, Paternoster-row, and W. C. Forster, Hatton-garden—Making paper

1061. H. Crowley, Manchester—Improvements in machinery for grinding bones. (A communication from C. T. Egeberg, Christiana, Norway)

1062. M. Poole, Avenue-road, Regent's.park—Improvements in machinery for splitting leather. (A communication)

1063. C. W. F. Aubusson, Warren-street, Fitzroy-square—Improvement in ferrules

1054. M. Poole, Avenue-road, Regent's-park—Improvements in engraving and printing on glass, and of figuring and ornamenting the same. (A communication)

1065. M. Poole, Avenue-road, Regent's-park—Improvements in fire-arms. (A communication)

1066. A. E. L. Bellford, Castle-street, Holborn—Improved method of retarding the process of decay in flour, meal, grain, and other vegetable substances. (A communication)

1067. A. E. L. Bellford, Castle-street, Holborn—Improvements in carriage-axles and their boxes. (A communication)

1068. W. K. Westley, Leeds—Improved construction of railway, and carriages to be employed thereon; applicable chiefly to farm purposes

1069. F. S. Hemming, Woodside, Birkenhead—Improvements in the manufacture of iron houses; part of which improvements is applicable also to the construction of sheds and fences

1070. F. Smith, York-street, Lambeth—Improved arrangement of furnace for consuming smoke

1071. A. V. Newton, Chancery-lane—Improved mode of separating granular substances of different degrees of fineness. (A communication)

*Dated May 13.*

1072. E. Barsanti and F. Matteucci, Florence, Tuscany—New or improved mode of applying the explosion of gases as a motive power

1073. J. A. Drieu, Patricroft, Lancaster—Improvements in machinery or apparatus for cutting fustians, velveteens, and other similar fabrics, to produce a piled surface

1074. C. Garforth, Dukinfield, Chester—Improvements in apparatus to be employed in the construction of the permanent way of railways

1075. R. C. Burleigh, Northumberland-street, Charing-cross—Improvements in steam-engines and other engines worked by the pressure of gaseous or other fluids, which are also applicable to pumps

1076. T. G. Shaw, Old Broad-street—Improvements in apparatus to facilitate the decanting of wine and other liquids

1077. H. H. Russell, York-buildings, Adelphi—Improved and ready mode of coupling, connecting, or joining

1078. H. Y. D. Scott, Queen's-terrace, Woolwich—Improved cement applicable as a plaster, or for moulding purposes

*Dated May 15.*

1079. J. V. H. de Ste Marie, Paris—Improvements in the means and apparatus for fixing capsules on bottles, vessels, or flagons

1080. L. F. Saugrin, Paris—Improvements in apparatus for the production of stereoscopic and photographic pictures

1081. R. A. Brooman, Fleet-street—Improvements in the manufacture of wheels for railway carriages. (A communication)

1082. R. Scott and T. Rowland, Basford, Nottingham—Improvements in machinery employed in the manufacture of knitted fabrics

1083. P. Prince, Derby—Retarding railway trains on the approach of danger, and for other purposes

1084. J. Chedgey, Grove, Southwark—Improved manufacture of rollers and cylinders, applicable to various kinds of machinery where a smooth, hard, and regular surface is required

1085. W. E. Newton, Chancery-lane—Improved machinery for cutting or shaping wood or other materials. (A communication)

*Dated May 16.*

1087. T. W. Miller, Queen's-place, Southsea, Hants — Improvements in railway-sleepers

1088. G. E. Dering, Lockleys, Herts—Improvements in obtaining motive power by electricity

1089. A. H. A. Durant, Tong Castle, Salop—Improvements in apparatus for sweeping chimneys and flues, and for extinguishing fires therein

1090. T. W. Miller, Queen's-place, Southsea, Hants — Improvements in railway-sleepers

1091. G. Mainwaring and W. A. Summers, Southampton—Improvements in supplying water for waterclosets, for the flushing of drains, and for general purposes

1092. J. P. Baker, Wolverhampton—Improvements in the construction of railway and other bridges, and in the method of lifting the same after sinking

*Dated May 17.*

1093. W. Smith and W. B. Hayes, Manchester—Improvements in power-looms for weaving

1094. R. Harris and R. W. Harris, Birmingham—Improvements in the manufacture of articles in glass

1095. G. Cheadle, Wolverhampton—New or improved lubricating composition

1096. H. Cornforth, Birmingham—Improvement or improvements in shaping and ornamenting metals

1098. A. V. Newton, Chancery-lane—Improved construction of tenon, and of machinery for forming the same, applicable to the manufacture of boxes for other analogous uses. (A communication)

1099. C. Catlow, Clitheroe, Lancaster, and T. Comstive, Burnley—Improvements in shuttles for weaving

1100. S. Diggle, Radcliffe, Lancaster—Improvements in looms for weaving

1101. L. J. Wetherell, Percival-street, Clerkenwell, and A. J. Hoffstaedt, Albion-place, Surrey—Improved construction of pump

*Dated May 18.*

1102. W. Coulson, Fetter-lane, York—Improvements in machinery for mortising and tenoning

1103. J. Worthington, Cardiff, and F. Allman, Adam-street, Adelphi—Improvements in boring, mining, and blasting, and in the apparatus connected therewith

1104. J. Horsfall, Birmingham—Improvement or improvements in the manufacture of wire for pianofortes and other musical instruments

1105. J. Beads, Pendleton, Lancaster—Improvements in machinery or apparatus for preparing, spinning, doubling, and twisting cotton, woollen, silk, linen, or other yarns

1107. W. Miller, Musselburgh, Midlothian—Improvements in bleaching flax, hemp, and other fibrous substances

1108. O. Maggs, Bourton, Dorset—Improvement in applying shafts to agricultural implements and carriages

1109. J. C. March, Barnstaple—Improvements in vices

1110. J. H. Johnson, Lincoln's-inn-fields—Improvements in printing telegraphs. (A communication from M. Theiler)

1111. J. Maclean and T. Finlayson, Glasgow—Improvements in the manufacture or production of ornamental fabrics

1113. J. C. Robertson, Glasgow—Improvements in the preparation and roasting of coffee and other substances
1114. J. Hinchcliffe, jun., Dam Side, York—Improvements in apparatus for regulating or governing the speed of steam-engines
1115. C. Barlow, Chancery-lane—Improvements in the manufacture of metallic capsules for covering or securing bottles and other vessels (A communication)
1116. J. Cunningham and W. Ashley, Liverpool—Improved apparatus for ventilating ships
1117. E. A. D. Guichard, Paris—Improvements in the manufacture of ornamental fabrics for decorating walls or other surfaces

*Dated May* 19.

1118. J. A. Haberhauffe, Grossmuhlingen, Germany—Improvements in fire-arms and projectile weapons
1119. E. J. Feuillatre, Paris—Improved apparatus for cleansing the wheels of carriages
1120. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in connecting the permanent rails of railways. (A communication)
1121. T. M. Gladstone, Salford, Lancaster—Improved traverser or machine for shifting railway carriages from one set of rails to another
1122. C. Rands, Shad Thames, Surrey—Improvements in machinery for regulating the feed of millstones

*Dated May* 22.

1123. T. Allston, Moorgate-street—Improvements in the construction of flues and chimneys for steam-engine boiler furnaces and other furnaces
1124. K. Rose, Commercial-road, Stepney—Improvements in buttons
1125. A. E. L. Bellford, Castle-street, Holborn—Improvements in looms for weaving. (A communication)
1126. A. E. L. Bellford, Castle-street, Holborn—Improvements in pianofortes. (A communication)
1127. W. Church, Birmingham—New or improved projectile
1128. W. Crighton and A. Crighton, Manchester—Improvements in machinery or apparatus, technically called "beaters," used for opening, cleaning, or otherwise preparing cotton, wool, or other fibrous substances
1129. E. Crossland, W. Holiday, and J. Heaton, Bradford, York—Improvements in apparatus employed in the manufacture of cast metal pipes or tubes
1130. J. Crossley, Newton-moor, near Hyde, Chester, and W. Crossley, Failsworth, Lancaster—Improvements in Jacquard machines
1131. J. Blake, Greenock, Renfrew—Improved shackle-hook
1132. R. A. Balbirnie, Great Malvern, Worcester—Improved mode of mounting ships' compasses. (A communication from W. A. Orr, Melbourne)
1134. W. England, Dudley, Worcester—Improvements in pneumatic and hydraulic wheels and fans
1135. L. Sauter, Paris—Improvements in lighthouses, and in lamps for lighthouses and other places
1136. H. S. Rogers, New Oxford-street—Improvements in fire-arms. (A communication from E. Whitney, U. S.)
1137. F. Clark, King-street, Whitehall—Improvement in fixing the spindles of door and other knobs and handles
1138. A. P. Rochette, Brighouse, York—Improvement in the manufacture of soap
1139. J. B. Spencer, Shooter's-hill-road, Kent, and A. J. Melhuish, Bowater-place, Greenwich—Improvements in photographic apparatus
1140. R. Oram and W. Oram, Salford, Lancaster—Improvements in hydraulic presses
1141. C. Bostock and S. Greenwood, Manchester—Improvements in machinery or apparatus for cleaning and doubling silk
1142. T. Storey, Phœnix Foundry, Lancaster—Improvements in stench-traps

*Dated May* 23.

1143. T. W. Atlee and G. J. Atlee, Birmingham—Improvements in printed or other forms, applicable for bankers' cheques, orders for goods, wharfingers' and carriers' receipts, taxes and rates collectors' receipts, and various other parochial, commercial, and private purposes, whether such forms be bound up into books or not
1144. F. Jenks, Handsworth, Stafford, and T. Brown, Birmingham—Improvement or improvements in saddletrees
1145. J. Biggs, Ightham—Improvement in the mariners' and other compasses by isolating and rendering them insensible to the disturbing influence of local attraction of iron, steel, and other bodies
1146. W. White, Cheapside—Improvements in hats and in hat-blocks
1140. J. Kucsynski, Rue de Rivoli, Paris—Improvements in preparing baryta and its salts
1148. E. Radigon and R. G. Grimouville, Paris—Improvements in glasses, shades, and smoke-plates, used in gas and other lighting
1150. R. Reyburn, Baker-street, Greenock—Improvements in refining sugar
1151. C. Levey, Little Queen-street, Lincoln's-inn-fields—Improvements in weaving bags and other tubular fabrics
1152. J. Lawson, Sidmouth-street, Gray's-inn-road—Improvements in the manufacture of cut pile fabrics
1154. J. Livesey, Bury Lancaster—Improvements in machinery for preparing or forming slivers of cotton, wool, and other fibrous materials for spinning or other purposes
1156. J. Smith, Henry-place, Bride-street, and F. S. Thomas, South-terrace, Walworth—Improvements in steering ships and other vessels

*Dated May* 24.

1157. F. Lipscombe, Strand—Improvements in guiding ships and boats
1158. J. Lillie, Manchester—Improvements in looms for weaving
1159. T. Clarendon and O. J. Gilsen, Dublin—Improvements in the means or apparatus for working breaks on railway carriages
1160. T. Ball, Nottingham—Improvement in manufacturing ornamented looped fabrics
1161. J. G. Jennings, Charlotte-street, Blackfriars, and R. Davenport, Jonathan-street, Vauxhall—Improvements in the construction of kilns for burning pottery and other ware

*Dated May* 25.

1162. E. O. Aston and G. Germaine, Millwall—Improvements in mariners' compasses to counteract the effect of local attraction
1163. J. M. Chevron and C. V. F. de Roulet, Paris—Improvements in textile fabrics, and in machinery for manufacturing such fabrics
1164. J. Harrison, Fitzroy-square—Improvements in pianofortes
1165. E. Everall and T. Jones, Henrietta-street, Brunswick-square—Waterproofing all kinds of cloth, clothing, silk, and leather, without injury to their respiratory properties, flexibility of fabric, colour, or appearance
1166. E. C. Mantrand, Paris—Improvements in the manufacture of phosphorus
1167. L. M. F. Doyere, Paris—Improvements in purifying grain
1168. J. W. Jeakes, Great-Russell-street—Improved construction of stove-grate
1169. J. Packham, Western-road, Brighton—Improvements in boilers used for heating and circulating water
1170. J. McGavin, Liverpool—Improvements in metal casks and tanks

*Dated May* 26.

1171. A. Livingston, jun., Portobello, Scotland—Improvements in earthenware pipes for drains and sewers
1172. J. A. Corwin, Newark, New Jersey—Improvements in knitting machinery
1173. G. Chilson, Boston, U.S.—New or improved furnace or heat generator and radiator, to be used for warming buildings or apartments, or for various other useful purposes
1174. S. Sweetser, Massachusetts, U. S.—Improvement in preparing skins or hides for the application of tanning thereto, or for being tanned. (A communication from W. A. Simonds, Massachusetts)
1175. M. Loomis, Massachusetts, U.S.—Improvement in the manufacture of artificial teeth
1176. W. Gossage, Widnes, Lancaster—Improvements in smelting or reducing copper ores, and certain other metallic compounds

*Dated May* 27.

1178. H. Distin, Cranbourne-street, Leicester-square—Improvements in drums for musical purposes, and in the mode of supporting and keeping them in the required position when in use. (A communication)
1179. J. Schmoock, Oxford-street—Improvements in the construction of children's and other carriages moved by manual power
1180. J. Hipkiss, Dudley Port, Stafford—Improvement or improvements in puddling-furnaces used in the manufacture of iron
1181. J. Murdoch, Staple-inn—Improvements in toy pistols. (A communication)
1182. W. Stenson, jun., Whitwick Collieries, Leicestershire—Improvements in steam-engine valves

*Dated May* 29.

1183. J. Stevenson, Grasless, Northumberland—Improvements in ploughs
1184. T. Bazley, Manchester—Improvements in and applicable to furnaces, and vessels used in connection therewith, for the manufacture of glass
1185. H. Kraut, Zurich, Switzerland—Apparatus applicable to cocks, taps, and valves
1186. J. Evans, Abbots Langley, Hertford—Improvements in the manufacture of ornamental paper and paper bands
1187. C. J. Pownall, Kensington—Improvement in communicating intelligence from one part of a railway train to another
1188. T. Taylor, Eddingley, Nottingham—Improvements in machinery or apparatus for distributing manure and vegetable substances

*Dated May* 30.

1191. J. Ridsdale, Minories—Improved means or methods of communicating between different parts of ships and other vessels
1192. F. Mordan, Frederick-place, Goswell-street-road—Improved inkstand. (A communication)
1195. E. Heinhold, Paris—Improvements in diurnal and nocturnal indicating apparatus
1196. H. Doulton, High-street, Lambeth—Improvement in the manufacture of junctions for sewers and drains
1197. M. Scott, Great George-street, Westminster—Improvements in joining or connecting pipes
1198. L. S. Middleton, Glasgow—Improvements in the manufacture or production of ornamental fabrics
1199. L. Wertheimber, Paris—Improvements in apparatus for preventing sea-sickness
1200. H. Colby, New York—Improvements in instruments for taking altitudes, levels, and angles, which he designates "Colby's Altimeter," or self-adjusting quadrant or sextant
1201. E. Loysel, Rue de Gretry, Paris—Improvements in grinding or pulverising vegetable substances, and in obtaining infusions or extracts from tea

*Dated May* 31.

1202. J. MacFarlane, Renfrew—Improvements in steam-boilers
1204. J. Kent, St. James's-square, Notting-hill—Improvements in harbour and river boats and other floating vessels, also in paddle-box boats
1206. W. E. Wiley and E. Lavender, Birmingham—Improvements in the manufacture of certain kinds of metallic pens
1208. C. C. E. Minnie, Paris—Improvements in projectiles

*Dated June* 1.

1212. D. Duncan, Crofton, York—Improvements in railway points or switches and crossings
1214. J. Arrowsmith, Bilston, Stafford—Improvements in steam-boilers
1216. W. Westrup, Old Ford—Improvements in the manufacture of wheat into flour
1218. S. Schwabe, Manchester—Making sulphate of soda or Glauber's salts. (A communication)
1220. O. Rowland, Lloyd-square—Improved apparatus for damping papers, labels, and other like articles

*Dated June* 2.

1222. T. Greenshields, George-street, Derby—Improvements in railway-chairs
1224. B. Stratford, Earl of Aldborough, Stratford Lodge, Wicklow, Ireland — Improvements in locomotion on land and water; part or parts of which are applicable to the raising of weights and the working of machinery
1226. M. Poole, Avenue-road, Regent's-park—Improvement in cop-tubes for mule and other spindles, and machinery for making such cop-tubes. (A communication)
1228. I. Taylor, Stanford Rivers, Essex—Improvement in producing thin metallic shells adapted to printing
1230. W. Wilkinson, Nottingham—Improvements in stamping, raising, or printing patterns upon leather, textile, thread, cut pile, or other similar fabrics, and also for dressing textile, cut pile, and other similar fabrics, previous to the stamping and printing

*Dated June* 3.

1232. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in the construction of umbrellas and parasols. (A communication)
1234. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in producing a useful substitute for leather in various applications. (A communication)
1238. J. S. Forstier, Carlton-hill—Improvements in railway-breaks, and in machinery connected therewith. (A communication)
1240. A. Chavanes, Rupert-street, Haymarket—Improvements in apparatus for indicating the time a public carriage is, and is not, engaged for hire. (A communication)

*Dated June* 5.

1242. J. B. Lindsay, Dundee—Mode of transmitting telegraphic messages by means of electricity through and across a body or bodies of water
1244. W. Crum and P. Stewart, Thornliebank, Renfrew—Improvements in machinery and apparatus for beetling or finishing woven fabrics
1246. H. Bordier, Orleans, France—Improvements in the manufacture of alcohol. (A communication)
1248. E. Maniere, Bedford-row—Improvements in getting peat, and in manufacturing peat with other matters into fuel. (A communication)
1252. S. S. Alison, Park-street, Grosvenor-square—Manufacture of a new material to be used for external applications in medicine

*Dated June* 6.

1254. W. T. Parkes, Aston-juxta-Birmingham—Improvement or improvements in the manufacture of the ornamental parts of gas-fittings
1256. D. Atkinson, Seaham Harbour, Durham—Improvements in printing, and in the machinery or apparatus to be employed therein or connected therewith

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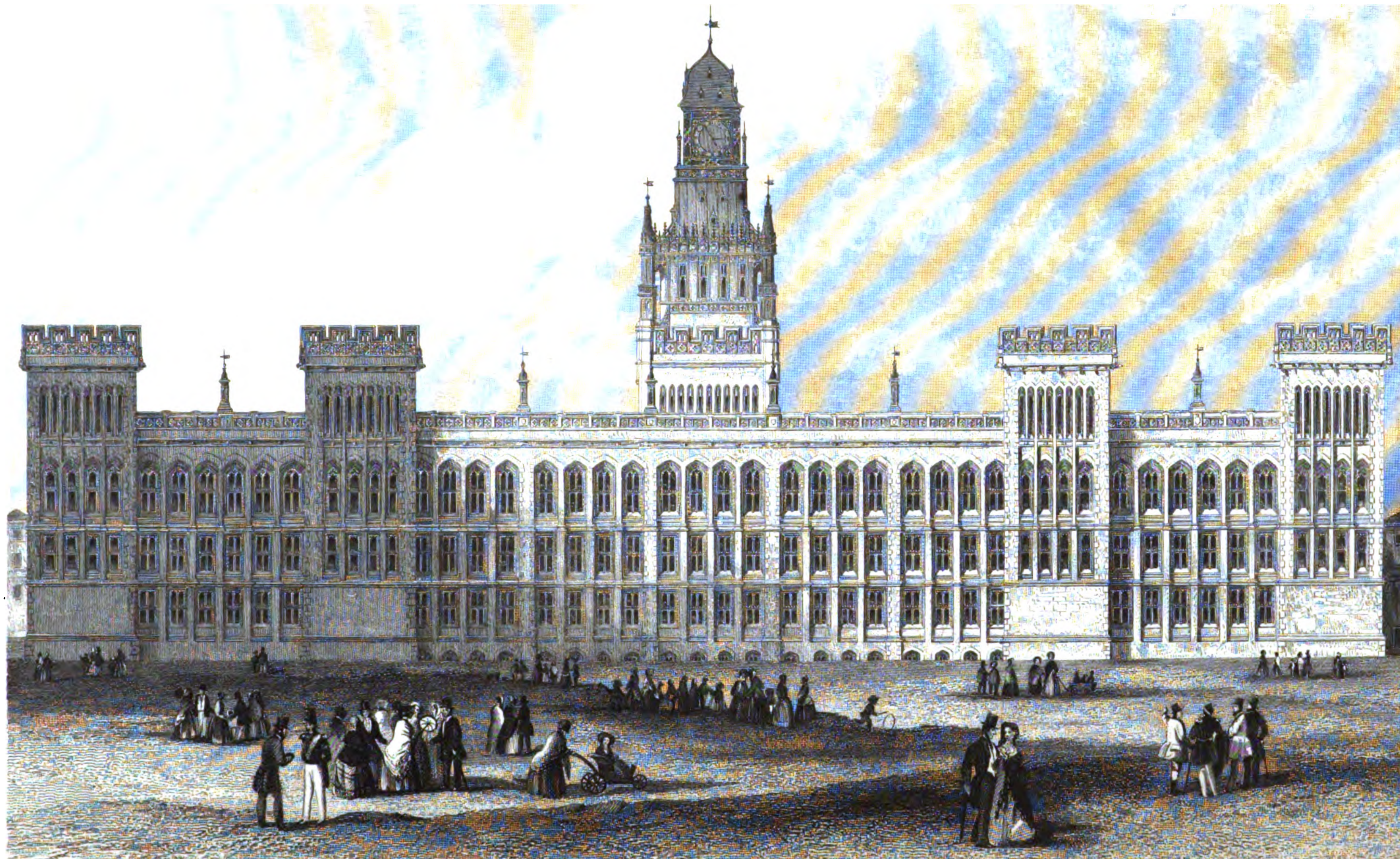
## PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

1153. J. Cox, Birmingham—Improvements in the manufacture of percussion-caps.—May 23
1257. N. Brough, Birmingham—Improvements in the manufacture of buttons, and in attaching them to articles of wearing apparel.—June 6

Pl. 27.




THE NEW RECORD OFFICE.

## NEW RECORD OFFICE, ROLLS BUILDINGS.

J. Pennethorne, Esq., *Architect.*

(*With an Engraving, Plate* XXVII.)

We present our readers this month with an engraving of the new Record Office, which the dangerous state of the national records so long imperatively demanded, and which have been hitherto scattered in a variety of places, exposed to destruction by fire or other causes, and always difficult of access. They are deposited, some in the White and Wakefield Towers in the Tower of London, others in the Rolls House, the Carlton Ride, and the Chapter House, Westminster. Some faint idea of the immense mass of national records may be gathered from the fact, that the Master of the Rolls has in his custody considerably upwards of 122,000 cubic feet of documents, to which will be added those from the Palace Court, the Durham records (already upwards of 40,000 cubic feet), together with an incalculable amount from all the holes and corners in which public records have been buried.

The building represented in our Plate is but partly erected, and stands between Chancery and Fetter lanes, on the Rolls estate. Its north front is intended to face a proposed new street, to run from the City to the West-end, coming out through the closely-packed district at the back of Drury-lane into Long-acre. In 1832, Mr. Deering prepared plans for a fireproof building, such as the present, for the late Record Commissioners, which were not acted upon, but other and more comprehensive plans devised by Mr. Pennethorne, from which the present structures have been erected. These consist only of the central portion included between the two wings of the building, which, including the basement, consists of eighty fireproof chambers, each 17 feet by 25 feet, and 15 feet in height; fifty-two of which are to be immediately fitted for the reception of records; twenty in the basement are to be arranged as workshops, or to contain documents not classified; and eight on the ground-floor to be searching-rooms, and offices for the requisite assistant-keepers and clerks.

The eastern wing, when erected, is to include forty-eight of these cubical spaces; and the western wing, which will occupy the sites of the Rolls House and Rolls Chapel, is to contain 100 chambers, making an aggregate of 228 cubical spaces: 200 of which will be eventually allotted to the reception of books and records; twenty for the use of the official establishment, and the remaining eight will be required for wells for two staircases. The 200 chambers are calculated to hold about 500,000 cubic feet of records.

The building is Late Gothic in style, and, from the depth of the buttresses (necessary on account of the number and dimensions of the windows diminishing its resisting capabilities), and the projections of the cornices and stringcourses, &c., it has a bold and substantial appearance. Two windows are provided to each room, and as these rooms are divided by galleries or iron floors, the windows are made proportionately lofty. The floors are formed with wrought-iron girders, supporting flat brick arches of nearly five feet span, laid on the top with white Suffolk tiles. The floor of each room is estimated to weigh about 26 tons, to which will be added a weight of about 64 tons of records, fittings, &c. This circumstance enforced the adoption of the dimensions of the rooms as already stated, instead of making them 15 feet by 27 feet as at first proposed. The brick walls will be coloured inside, without plaster. Externally the walls are of Kentish rag stone, dressed with Anston stone. The hall, entered from the south side, is to be lined with Portland stone, with a zinc panelled and emblazoned ceiling.

The sashes and door-frames are of metal, the doors themselves being formed of slabs of slate. The roof is iron. The clock-tower (already built to the height of the third story) is over the entrance on the opposite side to that shown in our engraving, and will, when complete, materially add to the effect of the building, and relieve the somewhat monotonous appearance of the multiplicity of buttresses and windows of which the main body of the structure consists.

The contractors for the building are Messrs. Lee, and for the iron work Messrs. Grissell. The estimate for the portions already built amounts to 40,000*l.*, not including the clock-turret.

## THE EDUCATIONAL EXHIBITION, ST. MARTIN'S HALL.

In compliance with a promise made at the conference of the representatives of various societies and institutions in union with the Society of Arts, an Educational Exhibition has been opened at St. Martin's Hall, of the utility of which those who have been engaged in instructing the young will bear faithful and willing testimony. There may be little in it to attract the worldly or the gay—the lover of sight-seeing, or one who cannot look below the surface of things; but the thoughtful and reflective will perceive in the materials here brought together the results of the combined efforts of England and foreign countries to explain to youth the truths of science, and open their mind to the beauties of art.

The original proposition for the formation of the Exposition embraced—

1. Plans, models, and drawings of complete sets or portions of buildings for educational purposes; the modes of warming, ventilating, draining, and lighting being explained in detail.
2. Specimens, plans, or models of the various fittings and articles of furniture required for the accommodation of teachers and their pupils.
3. Specimens or samples of materials and apparatus of a cheap and simple description, applicable to the use of schools with limited funds, or of superior schools for teaching practical sciences.
4. Books, maps, prints, and diagrams.
5. Results: including specimens, from schools, of drawing painting, and needlework done by pupils in schools.
6. Projects for supplying desiderata.

After some days spent in careful scrutiny of the materials composing the Exhibition, we can faithfully affirm that the whole of these objects have been carried out by the exhibitors; and we are anxious to direct the attention of our readers to the Exposition generally, and in particular to those parts of it which bear upon art—the department in which they may be presumed to take the greatest interest.

The call of the committee has been responded to in England by the National, the British and Foreign, the Wesleyan, and Congregational Educational Societies, and they exhibit to public view the materials by which the pupils in their schools are instructed in science and art; the same has been done by France, Belgium, Holland, Norway and Sweden, Switzerland, the United States, and nearly thirty cities of Germany. Of our public schools intended for the upper classes, Woolwich would seem to be the only one represented in the Exhibition, and that sustains, we are happy to say, the credit of the country We are presented with books used in the various courses of study, fortification and military drawings and plans, done by the cadets with great taste and skill; the whole series so arranged and laid open that visitors are enabled, by inspection, to form an accurate judgment of the entire plan of education pursued in the first military college in the British empire.

We would call the attention of parents and guardians to the remarkable fact, that nearly the whole of the educational apparatus to be met with in the Exhibition, would appear to be extensively used in educating the children of the poor; and we suggest, as a matter worthy of inquiry of those to whom they entrust the education of their sons, whether equal pains are taken to make them acquainted with natural and experimental science, as the national schoolmaster adopts with the child of the peasant or artisan. We very much fear that the middle class will fall behind in the career of improvement unless greater exertions on the part of the teacher, and greater demands on the part of the parent, should compel the adoption of those methods of illustration which are here brought, in such abundance, before the view: we trust that the apparatus and illustrations, so excellent of their kind and procurable at so small an expense, will be most extensively used in places of education which rank much higher in the social scale than National and British schools, and that public attention will be aroused to the necessity of making demands of at least equal attention, in this respect, from those who conduct schools intended for the middle and higher class of society.

Among the subjects to which the attention of the National Society has been especially directed, is that of offering school materials at the lowest possible price. In the catalogue will be found a list, with the prices of each article attached: one may be quoted. A pair of school 18-inch globes may be procured by members for 5*l.* 10*s.*, by non-members for 7*l.* 10*s.*; the specimens shown indicate them to be of very excellent quality, and indeed ornamental—though the stands are not finished with the elegance of a piece of drawing-room furniture.

The numerous articles illustrative of natural philosophy, would seem to show the tendency of the age towards the practical application of nature's laws. The time seems to have passed, as regards England, France, and the Teutonic nations, when it was considered sufficient that the philosopher in his study should alone investigate natural forces. Pneumatic apparatus, the mechanical powers, sections and models of the steam-engine and electrifying machines, may be met with in various parts of the Great Hall. The British and Foreign School Society exhibits largely this class of apparatus, and their illustrations may be advantageously compared with those from Norway which stand in juxtaposition. Mr. Highley supplies a valuable and extensive series of illustrations of the various sciences connected with natural history and geology; but we apprehend that they are of such a character that they will only find purchasers among professors of colleges, seeing that they are more adapted for young men than for school boys: we decidedly bestow upon them the highest approbation.

As it is not our intention in this paper to enlarge upon the general scope of the Exhibition, but rather to take up that part of it to which our readers may be expected to pay most attention, we shall conclude this portion by expressing a grateful feeling to the Committee of the Society of Arts, to whose labours we are indebted for the collection in one spot of so many valuable adjuncts to the art of teaching. Here the schoolmaster from the country may inspect the best books, maps, and diagrams which London publishers can supply, all of which are conveniently arranged in a room by themselves, and, from the numerous visitors usually met with, we should apprehend that the value of the collection was duly appreciated. The catalogue, in this department, is full and explicit; and thus nothing is wanting to complete the accommodation of those for whose advantage the Exhibition was designed.

The architect who is called upon to provide school accommodation may advantageously consult the various plans and models which are here laid before him: to enter into a discussion on the advantages of each would be beyond our province; but we would direct attention to the model of the Borough Road School, of the Greenwich Hospital School, and of a very complete scholastic building suited for a large parish, models and plans of which are exhibited by Earl Granville. Comparison may be instituted between these and foreign plans, of which many have been sent from various nations, and thus with little labour a great assistance may be obtained. Desks for masters and pupils, easels for slates, and other contrivances to facilitate the internal arrangements of schools, are to be met with here; and as these are matters of great importance, and not such as frequently come under the notice of architects, they will be found most useful. Their dimensions are the result of experience, and are such as that best of all teachers has shown to combine convenience of accommodation with economy of space.

Among the means of warming and ventilation are exhibited school and cottage grates,—those especially by Mr. Pierce, of Jermyn-street, which obtained a medal at the Exposition of 1851, demand attention not only from the builder, but from any one about to furnish a house: he may here inspect "fire-lump grates" of all sizes and prices, from the simple cottage, 24 inches wide, price 11*s.* 6*d.*, to the complete range fit for a large family. The plan on which they are constructed seems perfectly consistent with sound principles,—the supply of air enters in front, and there will be the greatest heat; which point, in grates of the usual construction, is at the bottom of the fuel, where abundant heat is useless. Instead of the fire being surrounded by iron, which abstracts the heat, it is walled-in with fire-brick, which, being a bad conductor, retains the heat and radiates it forth into the room.

We were pleased to see the whole series of progressive lessons in drawing and painting taught at the Marlborough-house School of Design. We have specimens of the examples supplied to the pupils and of the pupils' work, all of which are excellent of their kind. The series commences with outlines, and proceeds by regular gradations till it arrives at drawings from the cast and from life with colour; and we are rejoiced to find that the study of art, on the best principles, is thus rendered available to a large class who, till lately, have had no opportunity of forming a correct taste. We trust, and fully expect, that a few years will produce a great improvement in the public taste in the form of ornamental articles of furniture, the patterns of carpets and paper for walls; in which manufacturers have hitherto failed, or succeeded only by accident. The beautiful forms of nature have been preserved in casts by Brucciani, who has retained in plaster the form of leaves and fruits most accurately, and we cannot but approve of these, as examples to be put before the student, in preference to many of the models which foreign countries would seem to adopt: those from Darmstadt, for instance, consist of unnatural combinations of geometrical solids—a cylinder intersecting a cone, a cone a sphere, and other anomalies of that nature. Such would certainly require great practice to be represented by a student, and may induce correctness of eye and hand; but since, in the fine arts, the imagination must be allowed free scope, we cannot but think that beauty should be the predominant idea in all their productions,—and certainly that is wanting in such almost impossible forms. If a student copies a sphere, there is beauty in the form and shading; still more in the exquisite forms of vegetable life; and greatest of all in the cast of the human figure. Hence, after a certain facility of hand has been attained, the right method is that which seems to be adopted at Marlborough-house, to lead the pupil at once to elegant natural forms, and thus to allow a knowledge of light and shadow to spring up in the mind at the same time that the taste for the exquisite receives cultivation. For general use in teaching landscape drawing, we would recommend the models by Harding, which may be seen in the Gallery; by various combinations of the most simple geometrical forms—the cube and the prism—he renders it possible to produce varieties of structure, such as cottages, houses, and churches, in copying which the pupil must of necessity follow the laws of linear perspective, of light and shadow, and acquire a breadth of shading which is most important in the practice of the art of drawing. It is in this very breadth of shadow that the specimens sent from the Academy of Arts at Cadiz are especially deficient, while in some of those from France the excellence is remarkable; a few sketches from the frieze of the Parthenon, on half-tint paper, with white and black chalk, are striking examples—with little work an effect is produced which is highly gratifying to the spectator, while the finished specimens in ornamentation and from the cast, which France exhibits, are among the most beautiful productions of art in the Exhibition, and will well reward an attentive study. We will not say that these drawings cannot be matched by the Marlborough school specimens, but certainly no foreign nation approaches them in freedom and beauty of execution.

On the question of art, alas! for the United States. Morally and commercially, America is a great nation. On the sea her ships compete with ours,—on the land her energy subdues the forest, and renders the desert a habitation for man; but as regards a conception of the grand and beautiful, she is yet a child. The United States have sent samples of the drawings of her youth, the incorrectness of which we could readily pardon, were it not that the examples put before them, as shown in the "American Drawing-Books," are of so mean and worthless a character that, in our capacity as public critics, we are compelled most emphatically to condemn them. We hardly know how to account for the entire want of taste which these exhibit, seeing that no country can boast of finer scenery or more beautiful natural forms in vegetable life. It would seem to be a necessity, that for man to appreciate nature he must be well instructed in art; that, as in the polished intercourse of the best society the manners are most natural, so in the cultivation of the fine arts the ultimate end of education ought to be a true appreciation of what is beautiful in nature herself. It must be either that an over-weening self-satisfaction prevents America from seeing her deficiency, or that, from want of specimens of the antique or of the great masters of art accessible to the million, she has yet to learn to see with the eye of an artist, and to discriminate between the false and the true. With all friendliness, we would urge upon the government representative a close inspection and comparison of the contributions of the European nations; and would hope that, if wisdom guides him, he will carry back with him some of our best examples, and hurl, one and all, his "American Drawing-Books" to the winds.

In the arrangement of the physical characteristics of a country, we apprehend English geographers may take a useful lesson from a series of maps of Scandinavia, for which we are indebted to Sweden. The first of the series shows, in the usual method of shading, the mountains, the valleys, and the plains; the second exhibits sections through every degree of latitude and longitude, whereby a scale of comparison is supplied for ascertaining the relative heights of each district of the country; the third distinguishing, by colouring of blue and green, the relative amount of verdure and water; while the fourth shows the political divisions of the country. The style of execution of the whole is good, as indeed are most of the contributions for which we are indebted to that country. In Sweden, the science of botany has, since the time of Linnæus, been cultivated with assiduity. For a pupil to enter the University from the middle school of Stockholm, he must present a *hortus siccus* of the plants of the country, collected and arranged by his own hand; we have one here laid before us, as well as the simple tools with which he is supplied to root the hardy plant from the rock, or gather it from the utmost boundary line of vegetation in the neighbourhood of perpetual snow. The *hortus siccus* supplies examples of form for students in the art of drawing, and thus, from the first, a taste for natural beauty is cultivated in the youthful mind. The whole of the contributions from Norway and Sweden are worthy of attentive inspection; and as regards the progress of art, we are led to conclude, from the specimens before us, that these our northern brethren are in advance of the central German States.

Any attempt to explain the laws of linear persective deserves commendation; two especially attracted our attention in the Exhibition. Mr. Kimber, a gentleman well known as an intelligent tutor, includes his subject within a rectangular glass box. Having fixed his point of sight, he draws the outline on the vertical side which is between it and the object, which will of course be seen through the glass. The standing lines of the outline, when viewed from the point of sight, will be found exactly to correspond with the boundary of the object, and thus the student will be convinced of the truth to nature of the laws determining perspective delineations.

Mr. Uddell, of the Training College, Homerton, arrives at the same result by different means. Between the object and the spectator he places, vertically, a wire-gauze screen; having fixed his point of sight, threads are extended from it to all the angular points of the object, the outline of which, being drawn on the screen, will be found to coincide with the object seen through and beyond.

Any person of experience in tuition will have found a difficulty in rendering clear to the comprehension, the truths involved in the "doctrine of the sphere." A small armillary sphere invented by Dr. Sujection, the government deputy from Stockholm, simplifies the matter in this respect, namely, that whereas in our contrivances to represent the sphere of the heavens, we elevate or depress the pole to an altitude corresponding to the latitude by means of the brass meridian, and thus give a movement of which there is no example in nature; in the sphere before us the horizon has a movement whereby it may be adapted, as in truth it ought, to any place on the globe.

In this survey of some of the most remarkable objects supplied by the Exhibition, it has been our desire to direct the attention of our readers to the Exhibition itself, which we hope will be visited by all who can command the opportunity. We have touched on the most prominent objects, especially those bearing on the practice of art; omitting those relating to education in general, among which, however, will be found many to interest every parent, guardian, or well-wisher of the young. During the century of its existence, the Society of Arts has done much to encourage invention, to stimulate exertion, and to reward merit in particular departments; it deserves and will receive the thanks of the community for its efforts in bringing together this practically useful Exhibition of the machinery of education. May it excite a desire in the minds of teachers to improve their style of instruction, and to aim at carrying out to the utmost the facilities here afforded them for illustration and simplification of great natural laws, for demonstrating the truths of science and art, and for rendering education a near approach to the definition of it by Dr. Whewell in his inaugural lecture, as "that which makes man a participator in all that the human mind has attained to, of the rational, the true, the beautiful, and the good."

## THE REBUILDING OF WESTMINSTER-BRIDGE.

REPORT *to the Lords of Her Majesty's Treasury, on the Tenders and Contracts with Reference to the Rebuilding of Westminster Bridge.*

MY LORDS—I have the honour to bring under the consideration of your lordships' Board the proceedings which I have thought it my duty to adopt, with a view to carrying into effect the intentions of Parliament in respect to the erection of a new bridge over the Thames at Westminster.

Previously, however, to entering upon the immediate subject of these proceedings, it will conduce to a right understanding of the subject if I lay before your lordships a condensed account of the present bridge, and of the circumstances which have led to the necessity for the construction of a new bridge at Westminster within little more than a century after the completion of the present structure.

Westminster-bridge was commenced in 1739 and completed in 1750, at a cost of 389,500*l.*, of which sum 197,500*l.* was raised by lottery shares, and 192,000*l.* advanced by Parliament. The management of the bridge and of the bridge estates was placed under the control of Commissioners,* whose powers were transferred by Act of last session (16 and 17 Vict. 4th August 1853) to the Commissioners of her Majesty's Works.

Owing, it appears, to defects in the foundations of the structure, settlements took place before the bridge was completed, which rendered necessary the reconstruction of two of the arches, and great expenses have at various periods been incurred in attempts to maintain it in a state of security. According to a Report of a Select Committee of the House of Commons, dated 5th August 1846, these expenses, including watching, lighting, and repair of the roadway, appear to have amounted, between 1810 and 1838, to 83,097*l.*, and between 1838 and 1846, to 107,124*l.*, making a total expenditure up to the last-mentioned period of 190,221*l.*

The state of the foundations of the piers, and the change which had been progressively effected in the levels of the bed of the river subsequently to the removal of Old London-bridge, appear to have rendered the security of Westminster-bridge an object of anxiety to the Commissioners having charge of the structure, and examinations are accordingly found to have been made, and Reports to have been addressed to the Commissioners on the subject at various periods between the years 1823 and 1844.

Measures for securing the piers of the bridge appear to have been thereupon adopted, and to have been in progress from 1839 to 1843; and it having been decided during these operations to increase the width of the bridge 12 feet, it became necessary for that purpose that nine of the fourteen piers by which the superstructure was supported should be extended in length on the south side.

In a Report made in 1823 by the late Mr. Telford to the Corporation of London, on the probable effects of the proposed removal of London-bridge upon the regimen of that portion of the river, he drew the public attention to the expediency of making provision for the security of other metropolitan bridges under the circumstances of the intended change; and her Majesty's Commissioners for Metropolitan Improvements, in the course of their inquiry, in 1843, into the merits of various projects for the embankment of the Thames, caused sections of the river to be prepared and laid before them by Mr. Page, showing the alterations which had taken place in the bed within the period of twenty years which had elapsed since the date of Mr. Telford's survey. These sections were appended by the Commissioners for Metropolitan Improvements to the first of their Reports to her Majesty, bearing date the 27th January 1844, and presented to Parliament on the 7th February 1844, together with evidence deducing from these sections the impracticability of permanently maintaining Westminster-bridge in its then position.

It was towards the close of the inquiries of that Commission that symptoms of the failure of certain of the piers first manifested themselves; and that the Bridge Commissioners were induced to suspend the progress of the repairs, and to defer the proposed additions to the structure.

The attention of Parliament having been directed to these circumstances, Committees of the House of Commons have at various periods inquired into the condition of the bridge, the practicability of maintaining it for traffic, and the expediency of constructing a new bridge in its place. These Committees sat in 1844, in 1846, and again in 1850.

The Committee appointed in 1844 "to inquire into the present state of Westminster-bridge, and into the expediency of continuing the present expenditure thereon, or of erecting a new bridge on or near the site thereof," reported, after having taken evidence on the subject, "that no case had been made out to justify the Committee in recommending to the House the pulling down the present bridge and the constructing a new one." The Committee of 1846 † reported, that on the evidence

* According to the Report of the Select Committee of the House of Commons, 5th August 1846, the Commissioners were 94; 26 of whom sat by virtue of their offices, 57 by virtue of their seats in the House of Commons, as representing the metropolitan counties, and 11 sat under Bridge Act, 9 Geo. 2.

† The views of this Committee on the subject of a contribution from the State are

which had been laid before them, a sufficient case had in their opinion been made out to justify them in recommending the removal of the present bridge, the construction of a new one, and the transfer, by Act of Parliament, of the Estates and property of the Bridge Commissioners to the Commissioners of her Majesty's Woods and Works.

The Select Committee of 1850 were instructed to "consider and report specially on the expediency of erecting a permanent bridge on or near the site of the present bridge." The Report of this Committee recommended the erection, in case of need, of a temporary bridge across the river, and the institution by her Majesty's Government of an inquiry for the purpose of ascertaining the most economical mode of building an improved bridge on or near the present site.

The Commissioners appointed by your lordships (20th May 1851) divided their inquiries into two portions: the one, "having reference to the question of a site for the new bridge," the other, "as to its mode of construction." After having considered the relative advantages of crossing the river in the respective vicinities of Charing-cross, Richmond-terrace, the India Board, and the present line of Bridge-street, they submitted to your lordships the following recommendations, viz.:—

"That the present bridge should be used as a temporary bridge until the new bridge shall have been constructed.

"That the new bridge should be constructed adjoining, or as near as possible to the present bridge, either on the north or south side thereof.

"That it should not have more than five arches, which should be of iron, with stone piers.

"That the bridge should not be less than 60 feet in width; that it should have a headway at the centre arch of 25 ft. 6 in. above the high-water standard called 'Trinity Datum,' and

"That no time should be lost in making preparations for the commencement of the work."

In conformity with these suggestions, Parliamentary plans were deposited under instructions given by my predecessors, Lord Seymour in 1851, and Lord J. Manners in 1852, in both instances for a bridge to be erected on the present site.

Upon my being appointed First Commissioner of her Majesty's Works, the subject of a new bridge at Westminster was, at a very early period, brought under my notice. The site, the width, and the headway to be allowed for the navigation were of course the points which chiefly pressed for my consideration.

It was at this period of my inquiries that I received a suggestion from Sir Charles Barry for changing the site of the proposed bridge to one near Derby-street, Westminster, a spot essentially identical with that to which reference has been already made in this Report as being in the immediate vicinity of the office of the India Board.

Although the adoption of this suggestion would have been attended with some advantage, inasmuch as it would have relieved the Houses of Parliament from the immediate proximity of the intended structure, as it would have secured the use of the present bridge until the erection of the new one had been completed, and as it would have lessened the distance between Charing-cross and the Elephant and Castle (an important line of traffic on the Surrey side of the river), yet it would have been open to the same objections with the other two localities to which I have adverted in this Report; a total change of site would have involved, both in the purchase of property for the approaches, and in probable compensation consequent upon the diversion of the traffic from the present line, a large and unanticipated expenditure, such as, after duly considering the sacrifice to be incurred on the one hand, with the advantages to be obtained on the other, determined me to adhere to the site for which the Parliamentary plans had been already deposited.

In connection, however, with the adoption of this site, the plan proposed for its appropriation appeared to be susceptible of some improvements. So far as the appearance of the Houses of Parliament was involved, I felt it to be my duty, in common with that of my predecessors at this Board, to consult the opinions of the architect of the building on the subject; on the more important question of the land traffic of the bridge, as compared with that of the navigation, a series of observations were conducted under my direction by Mr. Page, the engineer in charge of the proceedings. The result of my inquiries was such as to satisfy me that both the appearance of the Houses of Parliament and the better accommodation of the land traffic of the proposed bridge might be promoted, without prejudice to the interests of the navigation, by the reduction of the headway at the centre arch from 25 ft. 6. in., recommended by the Commissioners of 1851, to 20 feet; and that in full accordance with both these objects, an agreeable promenade might be obtained for the public in one of the most crowded localities of Westminster, by increasing the width of the proposed structure from 60 feet to 80 feet.

Another suggestion made by Sir Charles Barry for placing the new bridge in a line at right angles to the river front of the Houses of Parliament, and thus accommodating the structure to the intended line of embankment on the Surrey side, was referred by me to several eminent architects, to ascertain their opinion as to the advantages which, as regards the appearance of the Houses of Parliament, would be attained by the adoption of the proposed modification.

The tenor of their reports, however, on that subject, and the interference which the change would have occasioned with property necessary for the approaches on the Surrey side, induced me to conclude that the advantages consequent upon the proposed change were not such as would justify me in authorising it.

Previously to bringing the subject of the reduced headway under the consideration of Parliament, I thought it right to acquaint the Lord Mayor of London, as Conservator of the River Thames, with my intention, and also with the considerations for the land traffic which had induced me to recommend this change. Upon the receipt of my communication, the Lord Mayor brought the subject under the notice of the Thames Navigation Committee, but as this Committee had fixed on 25 feet as the minimum amount of headway to be allowed for bridges in the metropolitan section of the river, the intended headway of 20 feet did not meet with their concurrence, and the Corporation of London, when the Bill came before the Committee, opposed it upon this point.

To show how the land traffic over the bridge, and the river traffic under it, would be affected by the proposed reduced headway, an accurate account was taken of both during five days preceding the sitting of the Committee; it resulted from these observations, that the average number of carriages of all descriptions which had passed over the bridge within twelve consecutive hours of each day was 9200, while only 50 sailing barges had passed under it, and these had, for the most part used an arch of the old bridge which had only 20 feet headway. This comparison, and the result of calculations which I had directed to be made as to the great saving of horse-power which might be effected by easing the gradients and reducing the headway as a necessary consequence of that step, were found to verify the representations made to me in favour of the adoption of a 20 feet headway, exclusive of the improved effect which would be given to the Houses of Parliament by the substitution of a structure, the roadway of which would be 10 feet lower than that of the present bridge.

The evidence given before the Committee in favour of the Bill, both by civil engineers and persons interested in the trade and navigation of the Thames, was such as induced the Committee to decide that a headway of 25 feet was not of such importance to the navigation of that part of the river as to justify so large a sacrifice to the interests of the land traffic, and the headway of 20 feet was finally adopted.

I should observe, that when it was determined by my predecessor, Lord John Manners, to deposit plans and sections for Parliament, it became requisite to decide upon the thickness of the crown of the arch at the centre of the bridge before the sections showing the gradients could be defined; and for this object, Mr. Page, the engineer to whom I had entrusted the preparation of those plans, made two designs of a character suited to the Houses of Parliament; one of these was for a bridge of three arches, the other for a bridge of five arches; on the last of them the estimate submitted to the Select Committee of the House of Commons was based.

The design for a bridge of five arches had been prepared in accordance with the recommendations of the Commission of 1851; but considering that arches of a larger span, with corresponding piers and spandrils, would not harmonise so well with the Houses of Parliament as arches and piers of smaller proportions, I decided (upon the assurance that the wants of the navigation would be amply provided for) to adopt a bridge having seven arches; which alteration, in addition to its other advantages, afforded better means of reducing the thickness of the roadway, and thereby reducing the inclination of the approaches. Besides the site, the number of arches, the headway, and the width of the bridge, there was another important element which governed my conclusions, and which it is right that I should mention to your lordships; I mean the embankment of the Thames. I am indebted to the labours of her Majesty's Commissioners for Metropolitan Improvements for much information upon that subject; a subject which, while it possesses but a partial interest in connection with that of the bridge, is one the importance of which to the welfare of the port of London cannot be overestimated.

The general embankment of the river, the formation of which is attributed to the Romans, has been proved by time to have been so judiciously executed as to secure to the Thames in regular navigable capacity (in breadth and depth), which constitutes the commercial value of a tidal river, a pre-eminence over all the rivers of England. This embankment inclosed the river, generally, within the limits which it now possesses, and brought into use or culture millions of acres of rich land con-

thus expressed in the Report:—"It is right to recollect that the case of bridges in the metropolis differs widely from the case of those in the counties of the empire; not only inasmuch as all the Queen's subjects have a common interest in their resort to her capital, and a share in the fame which its aggrandisement reflects on all her dominions, but especially because, perhaps from this cause, the State did in fact erect the only bridge which for centuries existed in London; and in the last century did create, directly and indirectly, by grants from the Treasury, and by money raised by lotteries, the very fund from which the present Westminster-bridge was actually itself built a hundred years ago. If, therefore, it be said that the nation does not erect bridges in the county towns of England, or did not erect the other existing bridges in the metropolis, it may be replied that the case of Westminster-bridge, built in a large part by annual votes from the Treasury, stands on different and now exclusive grounds; that the structure has been adopted by the nation, and that when Parliament enacted (*see* 9 Geo. 2, c. 29, s. 20), first, that it should be extra-parochial, and secondly, should not be a county bridge chargeable either to Middlesex or Surrey (*see* same Act, s. 21), it sanctioned its claim to be national, and to be sustained at the expense of the empire."

tained in the marshes between the embankments and the bases of the hills on each side of the river; a work the difficulty of which may be judged of by the fact that the levels of some of these marshes are as low as from 5 feet to 12 feet below the level of the highest tides.

The maintenance and repairs of these general embankments were managed, after the Norman Conquest, under Commissions issued direct from the Crown; but in modern times, within the limits of the metropolis, additional embankments, encroaching on the waters of the Thames, appear to have been permitted, in some cases without any authority whatever, in others by license from the Corporation of London, and in others by the authority of Parliament; which last class of cases, however, is limited to the forty-foot way constructed between the Tower and Allhallows, after the occurrence of the Fire of London in 1666; to the embankment made in front of the Temple in 1767, when Blackfriars-bridge was erected; to another carried out in front of the Adelphi in the year 1770; and to the embankment connected with the building of Waterloo-bridge in 1814.

The evils attending the want of some defined line of embankment, and the projection made into the river at the period of the commencement of the present Houses of Parliament, induced the Corporation of London to institute a general survey of the river in 1841. The line of embankment then projected under the authority of Mr. James Walker and others was approved by the Corporation; and although it has never been formally sanctioned by the Government, is the line of maximum projection at present generally adopted.

In the two instances in which lines of embankment have been laid down under the direction of her Majesty's Commissioners for Metropolitan Improvements, viz., that of the embankment between Westminster and Blackfriars Bridges, projected in 1844, and that between Battersea and Vauxhall Bridges, projected in 1845, and now in course of execution, the lines of embankment laid down on the Middlesex side of the river differ in certain points from the line which has been approved by the Corporation of London.

On the Surrey side of the river, although no line of embankment contiguous to Westminster Bridge can be said to have been adopted by the Government, yet as there appeared a probability that the line approved by the Corporation for the Surrey shore might at some future time be acted upon, and as I had been advised that it was practicable to form an embankment to this line, with advantage to the public, there appeared to me to be no sufficient reason for deviating to any extent from this line for the Surrey abutment of the new bridge. The fixing of this line, therefore, determined the length of the bridge proper, and its waterway, and enabled the engineer to state these elements before the Committee; the former he gave at 827 feet, the latter at 755 feet.

After the Bill had passed the Legislature, instructions were given to Mr. Page to prepare an elevation for a bridge of seven arches, and to place himself in communication with Sir Charles Barry during the arrangement of the architectural portions of his design.

The consideration which I had been enabled to give to the subject during the progress of these preliminary proceedings, induced me, upon Mr. Page's recommendation, to sanction further alterations in the general character of the structure; namely, an increase in its width from 80 to 85 feet, the introduction of flatter arches, and other modifications which, while they will be advantageous both to the public and to the appearance of the Houses of Parliament, will not, in execution involve a proportionate increase of expense.

The design having been at length completed, the working drawings and specification were made out, the quantities ascertained, and notifications issued to certain parties that the Board were prepared to receive tenders for the execution of the work. In the last-mentioned stage of these proceedings there were two arrangements open to my selection, each of them involving, as your lordships will be aware, a principle of great importance in the execution of large undertakings of this character. The one would have assigned the iron-work to the competition of the iron trade exclusively, the general services of the bridge, excepting services involving iron-work, being limited to that of experienced builders. This proceeding would have involved the necessity of two contracts in respect of the same undertaking, a division of responsibility between the respective contractors, and a risk of the works of one portion of the bridge being impeded in their progress by delay, or alleged delay, on the part of the contractor for the other. The second arrangement open to me was to obtain a contract in gross from one contracting party, which, whether representing an iron firm or a building firm, should be responsible to the Board for the due fulfilment of every portion of the work. The opinion of the Board's engineer having been favourable to the adoption of this latter course, and having been concurred in by one of the highest practical authorities on these subjects in the kingdom, I authorised applications for tenders in gross to be issued accordingly.

In the list of contractors applied to, most of the great iron firms were included. The great pressure of business, however, the uncertainty of the markets both in materials and in labour (especially the latter), and the fact that the undertaking would comprise so much work to which they were not accustomed, led to most of the great iron houses declining to enter into competition. It was owing to the same causes probably, and under some apprehension of the responsibility which would attach to the maintenance of the present bridge during the progress of the intended structure, that many of the building contractors adopted a similar course. Thus, on the day appointed for the delivery of tenders, offers from the following parties only were sent in, viz.: from Messrs. Myers, of London; Mr. Lawton, of Newcastle-upon-Tyne; and Messrs. Mare and Co., of London. Of these offers, that of Messrs. Mare and Co. was the lowest.

The correctness of the gross amount of the lowest tender had, thereupon, to be examined by reference to the detailed quantities and prices upon which, in common, the tenders had been severally founded; and this examination having been completed, and an omission in the tender of Messrs. Mare and Co. having been supplied, it was found that the amounts for the work, as intended to be executed, viz., with cast-iron piles and plates in the foundations, and with Cheesewring granite, as the material to be used in portions of the piers, were as follows, viz.: Messrs. Myers, 286,701*l.*; Mr. Lawton, 269,414*l.*; Messrs. Mare and Co., 207,438*l.*

For the maintenance of the present bridge, for the purchase of materials not used in the new bridge, and for the removal of the present bridge; the tenders were these, viz.:—

| | Maintenance. | Allowed by Contractor for remainder of Materials, and Removal. | Charge for Removal. |
|---|---|---|---|
| | £. | £. | £. |
| From Messrs. Myers ... | 3400 | Nothing. | 13,729 |
| From Mr. Lawton ...... | 1500 | 89 | Nothing. |
| From Messrs. Mare...... | 5000 | 6000 | Nothing. |

Thus, for building the new bridge, for maintaining the present bridge, and for the purchase of the remaining materials of the same, the tenders were—

| | £. | | £. | | £. | | £. |
|---|---|---|---|---|---|---|---|
| From Messrs. Myers . . | 286,701 | + | 3400 | + | 13,729 | = | 303,830 |
| From Mr. Lawton ...... | 269,414 | + | 1500 | − | 89 | = | 270,825 |
| From Messrs. Mare ... | 207,438 | + | 5000 | − | 6,000 | = | 206,438 |

The tender of Messrs. Mare and Co. was, therefore, 96,160*l.* below that of Messrs. Myers, and 63,158*l.* below that of Mr. Lawton. The amounts of the tenders from Messrs. Myers and Mr. Lawton were so great, and so much in excess of the estimate of the Board's engineer, as would have prevented me from accepting either of them under any circumstances, and the only tender which I felt myself justified in accepting was that of Messrs. Mare and Co., subject to two conditions, viz., that the examination of their detailed quantities and prices should verify the gross amount of their tender, and that the acceptance should have your lordships' approval.

Shortly, however, after this determination had been communicated to the parties, it was alleged by Mr. Lawton, that the tender of Messrs. Mare and Co. was deficient in certain particulars; that the deficiencies were such as to take it out of the list of tenders, under the terms of the specification, and, consequently, to render the tender of Mr. Lawton the lowest in amount.

I therefore caused an investigation to be made into the detailed quantities and prices on which the tender of Mr. Lawton had been founded, as well as into those which appertained to the tender of Messrs. Mare and Co., the result of which showed that in both cases there were certain omissions and irregularities which, on a strict construction of the conditions in the specification, would exclude the tenders of both these parties. I therefore came to the conclusion that it would be right to reject the tender of Messrs. Mare and Co., as well as those of Messrs. Myers and Mr. Lawton.

The amount of Messrs. Mare and Co.'s tender was, however, so near that of the estimate of the engineer, and the examination of their schedule had proved their prices to be so fair and reasonable, that considering the importance of taking advantage of the season, and of avoiding a probable increase of expense by recurring to competition, I deemed it right, in signifying the rejection of their tender, to leave it open to Messrs. Mare and Co. to make another offer for the execution of the work. This led to their re-examination of their schedule and tender, and to the filling up of certain omissions, the result of which was an offer from them to undertake the contract for the works of the new bridge, including the maintenance of the present bridge and its subsequent removal, for the sum of 206,438*l.* This offer I have, therefore, accepted, subject to the approval of your lordships.

I would here draw your lordships' attention to the estimates which have been laid before Parliamentary Committees at various times, by eminent engineers, for a new bridge at Westminster, on a site near to the present, and of a width varying from 44 to 60 feet. These estimates have been stated at from 90,000*l.* to 240,000*l.* for a bridge with iron arches and stone piers; and from 280,000*l.* to 360,000*l.* for a stone bridge. In referring, however, to the lowest of these amounts, I would observe that a lattice bridge, a girder bridge, and even an iron bridge with the stone balustrade of the existing bridge placed upon it, have formed the subject of suggestions at various times. The expense, however, of a bridge in this situation, as your lordships will be aware, must be determined in great measure by the conditions which govern the design, as the design itself must in fact be governed by that of the adjoining structure.

The estimate made by Mr. Page from the detailed quantities of the seven-arched bridge amounted to 203,826*l*., exclusive of allowance for contingencies and professional charges; for these, a sum of 10 per cent. is to be added, making the whole estimated cost of the structure 224,208*l*.

An expense will then have to be incurred (in accordance with the stipulations of the Corporation of London) for dredging the river to the depth of 12 feet below the level of low-water, to a distance beyond the limits of deviation shown on the deposited Parliamentary plan; for which service, for concreting round the piers, and for providing floating fenders, a further outlay of 10,792*l*. will have to be incurred, making the sum for which it will be necessary to provide for services of every kind 235,000*l*.

Taking the total estimated cost of the bridge therefore, including the various contingencies to which I have above adverted, at ... £235,000

The funds applicable to this service may be stated as follows, viz. —

| | | |
|---|---|---|
| I. Value of the Bridge Estate, according to a valuation prepared in the year 1844 by Mr. Hardwick, the Surveyor of the Bridge Commissioners ........................ | £172,571 | |
| II. Rents ........................................... | 7,497 | |
| III. Estimated produce of investments in stock, and amount of cash at present in the hands of her Majesty's Paymaster-general..................... | 36,162 | |
| | | 216,230 |
| Leaving an apparent deficiency of ................. | | £18,770 |

Your lordships will observe, that the amounts given under the first and second heads of the above statement are calculated on the assumption that the whole of the estate will have been sold before the termination of the present year; I propose, however, that the property shall be disposed of in portions only, and from time to time, as the state of the market shall suggest, and as occasion shall appear to require. It is probable, therefore, that the sum which will be ultimately realised in the shape of income from the property may be greater than the amount above stated; and I am, moreover, informed by Mr. Hardwick that the fee-simple value of the estate may be considered to have rather increased than diminished since the date of his valuation (already referred to as having been made in the year 1844); I have, however, no reason to believe that any increase which may be realised under these circumstances will be sufficient materially to reduce the present apparent deficiency; and as a portion of the fund invested to the extent of 8000*l*. has been set apart as a provision for the annuity granted by your lordships' Board to the late treasurer of the Bridge Commission, and may possibly remain unavailable until after the bridge shall have been completed, I would suggest to your lordships the expediency of Parliament conditionally appropriating to this Board a sum not less than 25,000*l*. in aid of its existing resources.

I have the honour to submit for your lordships' approval a plan and elevation of the proposed bridge, and to request your lordships' authority for proceeding with the execution of the work.

William Molesworth.

*Office of Works, &c., April 19th*, 1854.

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P.S.—In a report to your lordships on a subject of such importance as the building of a great metropolitan bridge, it may not be out of place to make a brief reference to the bridges already erected over the Thames in the metropolis, for a comparison of their main features in dimensions and expense with the New Westminster Bridge.

Old London Bridge, the erection of which has been traced to the year 1176, consisted of twenty arches, with a lineal waterway of 450 feet above the starlings. Subsequently to the introduction of the great central arch in 1759, the waterway above the starlings was 545 feet, and below them 258 feet. The bridge had a row of houses on each side of its carriage-way, noble gateways, a chapel, and other buildings of architectural merit. The width between the houses was 20 feet, but after the removal of the houses in 1754, the total width of the bridge between the parapets was 45 feet.

The second bridge erected in the metropolis was the present Westminster Bridge, built of Portland stone, and completed in 1750. It consists of thirteen arches and two small culvert arches, and has a waterway of 820 feet at high-water mark. The height or headway at the centre arch was 26 feet above the Trinity datum. The width of the carriage-way is 28 feet, and of each of the two footpaths 7 feet; the steepest part of its approach was originally 1 in 15, which was reduced by subsequent alterations to 1 in 22. The sums expended on the bridge and approaches amounted, as before stated, to 389,500*l*.

The third metropolitan bridge was Blackfriars Bridge, begun in 1760, and completed and opened in 1769. It was constructed of Portland stone, at a cost of 180,506*l*., including the temporary bridge. It has nine arches, varying in span from 70 feet at the sides to 100 feet at the centre; a headway at the centre arch of 27 feet above Trinity datum; a width of carriage-way of 27½ feet, with two footpaths of 7½ feet each. Its steepest approach was 1 in 16, but that has been reduced to 1 in 24.

The fourth bridge in order of completion was Vauxhall Bridge, which was commenced in May 1811, and opened July 1816. The cost, including road and approaches, was 297,000*l*. It has nine arches of iron on stone piers, a waterway of 675 feet, and a headway at the centre arch of 26 feet above Trinity datum. The width of its carriage-way is 24 feet, and of each of its footpaths 6 feet. The steepest gradient of its approaches is 1 in 30.

The fifth bridge completed was Waterloo-bridge, commenced in October 1811, and opened in June 1817. It is constructed of granite, and has nine arches, each of which is 120 feet in span, giving a waterway of 1080 feet, with a headway of 27 feet above Trinity datum. The cost of the bridge was 572,415*l*., and of the approaches 337,972*l*., making a total of 910,387*l*. Its roadway is 27¼ feet in width, and each of the two footpaths is 7 feet in width. On the Middlesex side the approach is nearly level, but on the Surrey side the steepest gradient is 1 in 31.

The sixth bridge in the order of completion was Southwark-bridge, which was commenced in May 1815, and opened March 1819. It consists of three iron arches (centre arch 240 feet, each of the side arches 210 feet), resting on stone piers, and has a waterway of 660 feet. Its headway at the centre arch is 30 feet above Trinity datum. The width of its roadway is 28 feet, and of each of the two footpaths 7 feet. The cost of the bridge itself was 384,000*l*., that of the approaches and river-side property and miscellaneous expenses, 312,000*l*., making a total of 696,000*l*. This noble bridge is remarkable for the great span of its arches; but the necessity of adapting its approach on the Middlesex side to the low level of Thames-street, has entailed upon it a steepness of gradient in this approach which is very disadvantageous to the traffic. The steepest part of the gradient is 1 in 22.

The new London-bridge was commenced in 1824, and completed in 1831. It is constructed of granite, and has five arches, the united waterways of which amount to 691 ft. 9 in. The span of the centre arch is 151 ft. 9 in., and the headway above Trinity high-water is 29½ feet. The width of the carriage-way is 35 ft. 6 in., and that of each footpath 9 feet, making a total width of 53 ft. 6 in. The cost of the structure itself is stated at 542,850*l*., which is exclusive of the expense of removing the old bridge. The property required for the approaches, and the purchase of which enabled the Corporation of London to complete this great metropolitan improvement, which was effected at the time, added a sum of 859,084*l*. to the amount of the bridge. This, however, included the removal of the old bridge.

Hungerford Suspension-bridge, for foot-passengers only, was commenced in 1841, and completed in 1845. It consists of three spans, the centre of which is 632 ft. 4 in., and the total waterway of the three is 1256 ft. 4 in. The height of the bridge in the centre is 27 feet above Trinity datum. Its width between the chains is 12 feet, and the cost, including the approaches, was 112,850*l*.

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*Treasury Chambers*, 27 *April* 1854.

Sir—I am directed by the Lords Commissioners of her Majesty's Treasury to acquaint you, that they have perused with much interest your report upon the New Westminster Bridge, dated the 19th instant, and that their Lordships are pleased to sanction your acceptance of the amended tender of Messrs. Mare and Co. for 206,438*l*.

My Lords are further pleased to authorise you to take immediate steps to carry this work into effect. With regard to the deficiency estimated at 25,000*l*. at the outside, my Lords will cause provision to be made in the Estimates for next year, or at such a time as the same shall be actually required for expenditure, and when the amount shall have been more accurately ascertained.

The First Commissioner of Works. C. E. Trevelyan.

## DRAINAGE OF THE METROPOLIS.

The following is the copy of a letter from the Chairman of the Metropolitan Sewers Commissioners, addressed to the office of the Secretary of State for the Home Department, upon the subject of the Drainage Works proposed by the Commissioners to be accomplished within the next twelve months, if they were allowed to raise a further loan of 300,000*l*:—

1, *Greek-street, Soho, July* 10, 1854.

Sir—With reference to the directions of Viscount Palmerston, which you communicated to me on the 8th inst., to send to his lordship, for presentation to the House of Commons, a detailed statement of the drainage works which it is proposed to accomplish with the money the Commissioners of Sewers would receive in the course of the next twelve months, if they were allowed to raise a further loan of 300,000*l*.; stating, also, the estimated expense of each work, the place in which it would be made, and the advantage which would result from it;

I beg to state, for his lordship's information, that the limited period within which the information is required to be furnished, precludes the possibility of assembling the Commissioners, and obtaining the decision of the collective body upon the question now proposed. At the same time, I am sufficiently possessed of the views of my colleagues to state what, in all probability, would be the decision of this Commission, if under fresh powers, they succeeded in raising a further loan of 300,000*l*. In the selection of works to be paid for by means of loans, the Commissioners have adopted the two following principles:—

1. To select for execution those works which are at once most urgently needed and calculated to afford the greatest amount of immediate relief, and which are, at the same time, of so costly a character as to exceed the means of being accomplished out of income.

2. To commence no work until the means of completing it are actually provided, or at least until there is a fair prospect of obtaining the funds necessary for completing it within a reasonable time.

The works which the Commissioners consider most signally to fulfil the former of these conditions, are the two great works embraced in the printed reports which I have the honour to enclose. Those reports, accompanied with plans, were presented to Parliament in an early part of the present session. Each of these works, though forming an essential part of the main drainage, or intercepting scheme, is so far independent of it as to be a perfect work in itself.

The first of these works is the Northern High Level (or Hackney Brook) Sewer, with its main branch, the course of which is shown upon the first map in the reports now transmitted, by the red lines traversing the area coloured yellow. The main line commences near Hampstead, and proceeds first in an easterly and then in a south-easterly direction, to the River Lea. The branch sewer commences at Kilburn, proceeds along the Edgware-road, then takes a north-easterly direction above the Regent's-Park, and joins the main line at Holloway.

| | Miles. | Feet. |
|---|---|---|
| Length of Main Line ........................ | 7 | 840 |
| Length of Branch.............................. | 4 | 4910 |
| Total .................. | 12 | 470 |

The entire cost, including all contingencies, is estimated at 300,000*l*.

The advantages incident to this work may be thus described:—

1. It will form the main line for the immediate drainage of an area of 14 square miles, comprising Hackney, Homerton, Clapton, Stoke Newington, Dalston, Kingsland, Highbury, Camden Town, Kentish Town, Highgate, Hampstead, Kilburn, and Portland Town; and it will afford an outlet for the immediate construction, out of the current rates, and also, to a large extent, at the cost of private individuals, of numerous local sewers now urgently needed for the benefit of entire districts, which are at present for the most part destitute of drainage.

2. It will render practicable the abolition of numerous foul open sewers, amongst others the Hackney Brook and a portion of the Fleet, which cannot now be dealt with for want of a proper outfall.

3. It will at once relieve all the main lines of sewers between it and the Thames, which are now greatly overcharged in times of rain, causing an extensive flooding of property; and it will enable many of those last-mentioned sewers, which are old and dilapidated, to be reconstructed of a smaller size at a proportionally reduced cost.

The second work consists of the entire system of drainage proposed in the same reports for the districts south of the Thames, and laid down in the other map. The outside cost is estimated at 750,000*l*.; though it consists of two great lines (with branches), viz., a high and a low level line, it must be regarded as one connected work; and the Commissioners, therefore, would consider it an improper course to enter upon the execution of either line, without a reasonable assurance of their being enabled to execute the other.

Supposing such an assurance to be obtained, then they would, in all probability, select the low-level line for immediate execution, as that which presents the prospect of the greatest immediate benefit. The cost of this lower line may be estimated at about 300,000*l*., including pumping station, engine power, &c. The advantages to be derived from this low-level line would be the following: it would provide a main trunk sewer, of sufficient depth for the drainage of the large district, coloured red, comprising seven square miles, and including Battersea, Clapham, Stockwell, Lambeth, Camberwell, Peckham, and other places, in which it is at present impossible to construct proper sewers, for want of a deep outlet. As in the case of the northern sewer, it would provide the means of abolishing numerous foul open ditches, and would afford considerable relief to the existing sewers which are present overcharged. To this may be added, that it would give an impulse to the construction of numerous sewerage works at private cost; and it would also, to a large extent, remove the sewage of the large area already described from the contiguous part of the Thames. The full utility, however, of this portion of the entire work, would not be developed until the high-level line should have been completed.

The execution, however, of any part of the southern works, must depend upon the ability of the Commissioners to obtain, by negotiation, on eligible terms, the land requisite for a pumping station near Deptford. If the Commissioners should have valid ground for the expectation that they would be enabled, at no distant time, to complete the whole of the two great works above described, it might become expedient that they should, with the proposed loan of 300,000*l*., execute a portion of each; a course which, it is conceived, would give satisfaction to the greatest number of persons.

RICHARD JEBB.

The Hon. Henry Fitzroy.

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In a letter to Lord Palmerston, subsequent to the above, Mr. Jebb states that the Commissioners propose to devote 110,000*l*. of the 300,000*l*. which the bill now passing through parliament will enable them to borrow, to the construction of so much of the northern high-level intercepting (or Hackney Brook) sewer as will extend from the present outlet of the open sewer to High-street, Stoke Newington; with the remaining 190,000*l*. they propose to construct the whole of the low-level intercepting sewer, from Deptford Creek to Battersea, except its northern branch, which extends from High-street, Deptford, to a point near Paradise-row, Rotherhithe.

The sum of 200,000*l*. which the act of last year authorised the Commissioners to raise, and which brought their debt up to 300,000*l*. (now to be 600,000*l*.), was borrowed of the Rock Life Assurance Company, at 4½ per cent. on the security of the rates, the money to be advanced by the company in ten monthly instalments of 20,000*l*. each, beginning on the 1st of March last.

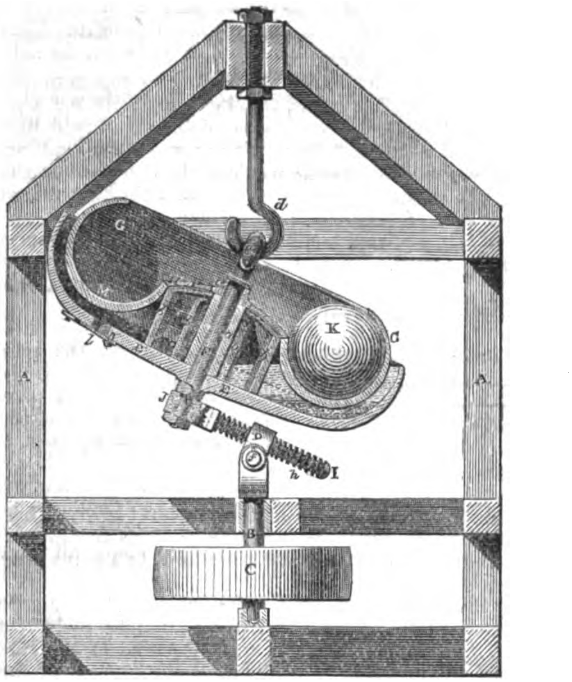
## MACHINERY FOR PULVERISING AND WASHING QUARTZ OR ORE.

AUGUSTE E. L. BELLFORD, *Patentee*, June 1853.

THE first part of this invention consists in the employment, for the purpose of pulverising quartz or ore, of a spherical ball placed within a circular basin, whose axis moves in such a way as to describe a cone around an imaginary fixed axis, but does not cause the basin to rotate. The basin is so formed that the ball nearly fits to its sides. The imaginary axis, round which the axis of the basin revolves, is intended to be vertical; and consequently, the bottom of the basin must always be in a similarly inclined position, though the position of the basin is constantly changing in such a way as to make all the points in any circle described from its axis, successively the lowest points in the said circle; every point moving as it were in a circular inclined plane. The ball will always descend by its gravity to the lowest place in the interior of the basin; but as every point in the circle of the basin in which the ball remains, commences ascending as it passes the ball, it has a tendency to carry up the ball with it. This tendency is overcome by the gravity of the ball, which causes it to rotate on its axis, in the same manner as a ball descending an inclined plane, and always keeps it at the lowest part of the basin, where, by its rolling motion, it is made to grind and pulverise the material placed in the basin. The peculiar movement of the basin admits of the quartz or ore being kept all towards the working point of the ball, and keeps the entire mass of its contents constantly and thoroughly agitated, so that all the particles are subjected alike to the action of the ball.

The second part of this invention consists in the combination, with a ball and basin, of an outer basin, placed below, with a space between it and the crushing-basin, moving with the crushing basin, and having communication with it.

The third part of the invention relates to a device for counteracting the too great centrifugal tendency which may be imparted to the crushing-ball by the revolution which it is caused to make around the axis of the basin and the imaginary axis round which the former axis moves. The axis of the basin receives its motion through a crank which acts at one end of it: and the increasing centrifugal force of the ball is made to shorten the effective length of this crank, and thus reduce the motion of the basin, and inclination of the plane which is presented to the ball.




The annexed engraving represents a section of this machine taken through the centres of both basins. A, is the frame of the machine, in the lower part of which is supported the driving-shaft B, which occupies a vertical position, and receives motion through a belt-pulley C, from any prime mover. The upper end of the shaft is forked to receive a block D, of metal, which is pivoted to it by a pivot F, passing transversely through the axis of the shaft. E, is the lower or amalgamating basin, of cast-iron and circular form, and having a hub *a*, projecting some distance from the inside of the bottom, which receives the shaft F, on which it is firmly secured. G, is the inner or crushing-basin, which is so formed as to make a trough or channel M, all round its bottom, to receive the ball. The raised circular part H, of the basin, within the trough, rests upon a number of bearing pieces *b, b*, which stand up from the bottom of the basin E; and it has a hub *c*, which fits to the shaft and rests on the hub *a*. The two basins are secured to each other and to the shaft by any suitable means. The raised circular part H, of the basin G, is open; the hub being merely united to the trough by radial arms, and the opening is covered by a screen L.

The upper end of the shaft F, is suspended by a hook *d*, and eye *e*. The lower end of the shaft is connected by a crank to the shaft B. This crank, instead of being a bar or block rigidly connected to the two shafts, consists of a rod I, which is fitted to work freely in a hole made in the block D, at right angles to the pivots F; at one end is pivoted a metal box J, which is bored to receive a journal *i*, on the lower end of the shaft F. A spring *g*, is applied between the block D, and a shoulder near that end of the rod I, to which the shaft F, is connected; and another spring *h*, is applied between the said block and a shoulder at the opposite end of the rod; both these springs exert their force by pushing from the block.

The operation of the machine is as follows:—The quartz, ore, or auriferous mineral, after being broken into small pieces, is fed in a suitable quantity to the basin G, and is there subjected to the action of the ball K. The stream of water which is let into the trough G, washes up all the finely-pulverised particles, and carries them through the screen L, to the basin E, containing the mercury, with which they are thoroughly amalgamated; while the quartz or other foreign mineral matter is washed away by the constant overflow at the lowest part of the edge of the basin E. The amalgam is withdrawn from the basin, through a suitable valve or trap *l*, in any part of the bottom.

The ball K, owing to the constant change in the position of the lowest portion of the basin, moves in a horizontal plane in a circle described from the imaginary central axis round which the axis of the basin moves, and thus acquires centrifugal force which tends to throw the lowest side of the basins from the centre. This centrifugal force is, in a certain degree, but not perfectly, counteracted by the gravity of the ball, which tends to lengthen the crank while the centrifugal force tends to shorten it. The shortening of the crank reduces the extent of the motion of the basin, and lessens the inclination of the plane down which it may be said to be descending, and thus arrests the centrifugal tendency. The springs *g*, and *h*, admit of the lengthening and shortening of the crank, and hold it at a desirable length when not otherwise unduly influenced, and also serve to prevent shocks to the machine in stopping and starting.

## BURSLEM TOWN HALL.

(*With an Engraving, Plate* XXVIII.)

OUR engraving exhibits a perspective view of the Burslem New Town Hall, the plans and description of which will be given in full next month. Mr. R. Hales, of Cobridge, Staffordshire, is the architect. Mr. Armstrong's design, which obtained the second premium in the competition, was in the Royal Academy Exhibition, and noticed by us at page 234.

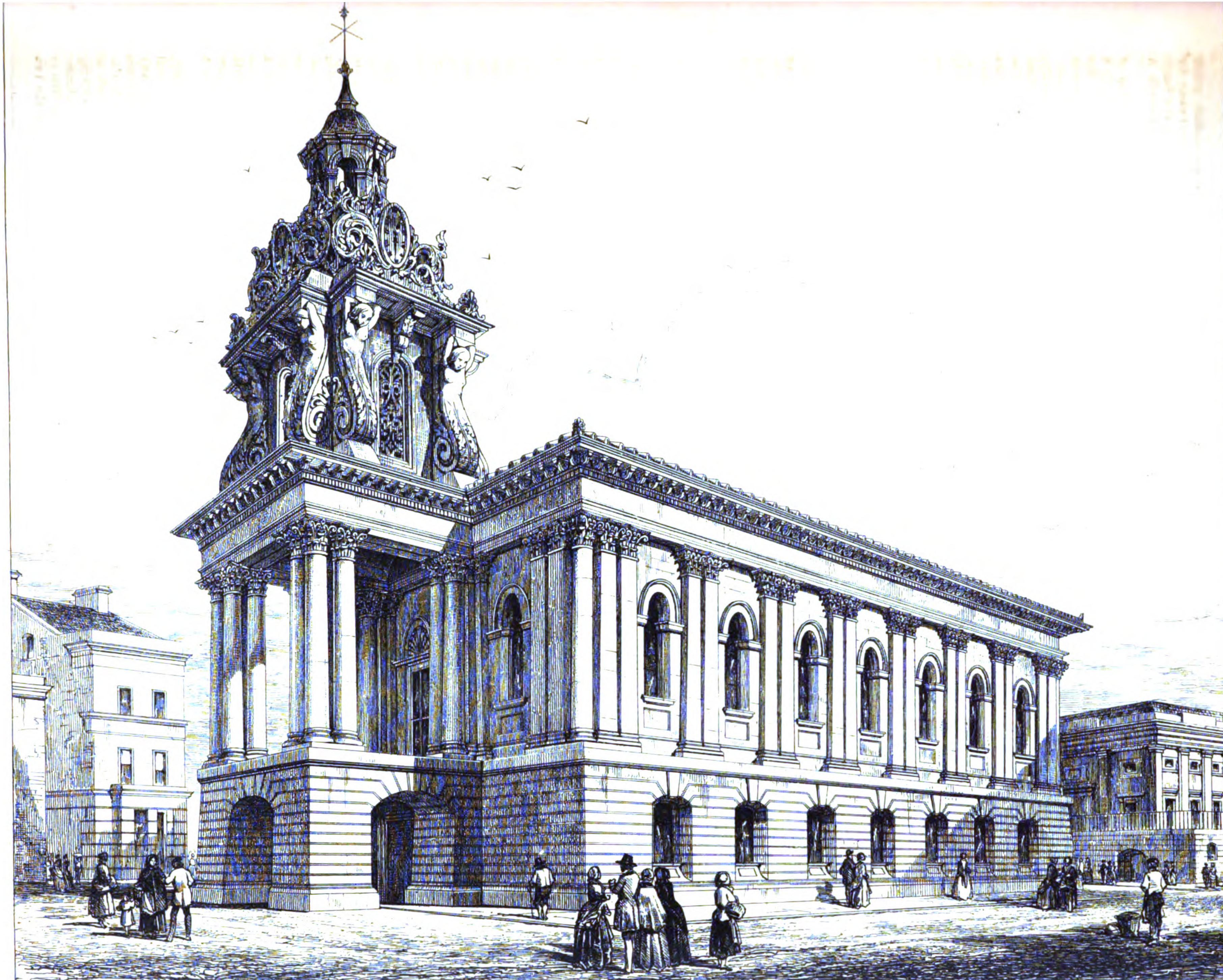
## VELOCIMETER FOR MEASURING THE SPEED OF SHIPS AND VELOCITY OF CURRENTS.*

THE object of this instrument is to measure the speed of ships, and the velocity of currents of air and water. Its principle is based on that of the vena contracta, which was discovered a century ago by Daniel Bernouilli, and has since been applied by Venturi in the double-cone tube which bears his name.

Mr. Overduyn, a Professor at the Royal Academy at Delft, has invented a velocimeter, the idea of which is based on the negative pressure, or rather the sucking action resulting therefrom, at the narrow gorge or section, where the two tubes of which Venturi's tube is composed, intersect each other. A tube, constructed on the same proportions as Venturi's, is fixed to the vessel in a direction parallel to its axis, the base of the smaller cone being turned towards the bow. A hole is made in the side at the intersection of the cones, into which a small pipe is fitted. As soon as the vessel is in motion, the negative pressure begins to exert itself, and increases proportionately with the speed of the vessel. All that remains to be done is to measure with precision this increasing negative pressure, whereby the increasing speed of the vessel is ascertained. This is effected by prolonging the smaller tube into a manometric case, on the plan used by Vidi in the construction of his aneroid barometer. Into this case is *inserted* the tube in which the sucking action takes place. The two ends of the case advance or recede according to the vacuum determined, and this vertical movement of the ends of the case is converted into a horizontal motion by means of a lever, and turns an index-point which marks on a dial the degree of velocity attained. It is almost useless to add, that these results may be turned to further advantage by the addition of a *totalisateur*, whereby the degree of velocity obtained after a given time may be arrived at.

In order to ascertain the velocity of currents in a river, &c., the tube must be immersed in the water, when the dial will show the velocity of the stream, which may be ascertained at any point of its depth by immersing the tube accordingly. Currents of air may be measured in the same manner; but when the double cone-shaped tube is used for this purpose, it should be made of larger dimensions, but in the same proportions. The sucking action of the tube may be rendered more powerful by enclosing it in a larger tube, care being taken to place the front orifice or mouth of the inner tube in the plane of intersection of the two cones of the larger tube.

* From the 'Moniteur Industriel.'




THE NEW TOWN HALL, BURSLEM.

G T ROBINSON, ARCH$^{T}$

## ON THE POSITION OF FIRE-PLACES.

By Dr. Neil Arnott, F.R.S.*

This is the fit place for remarking on the fashion lately introduced in this country of placing the firegrates much lower down than formerly—in some cases, on the very hearth—the reasons usually assigned being that a low fire burns better, or gives out more heat from the same quantity of fuel, than a higher; and because lower and nearer the floor, that it must warm the carpet better, and so lessen the evil of cold feet. Now, both these suppositions are curious errors or delusions, having their origin in popular misconceptions respecting heat, and particularly respecting the radiation of heat.

Radius is the Latin word for the spoke of a wheel, and anything which diverges or spreads around from a centre, in some degree like spokes, is said to radiate. Light and heat are of this nature; the portion of either which passes in a straight line from the centre is called a ray.

The simplest observation teaches all that a lamp placed in the middle of a room radiates its light and heat nearly equally in all directions; and most persons are aware that if an opaque mirror be placed close to a lamp on one side, it not only intercepts all the rays that fall upon it—and that means nearly half of the light given out—but it returns or reflects these rays back in contrary corresponding directions, and nearly doubles the illumination in those directions.

Most persons, also, have observed that if a fire, or a red-hot mass of metal, be placed in free space, it radiates its heat as well as its light nearly equally in all directions; but many do not learn, by their unaided observation, that if a surface of any substance, like firebrick, which strongly resists the passage of heat through it, be placed near a fire, it not only intercepts the heat-rays falling on it, but after absorbing them, and so becoming heated, often to redness, it then reflects and radiates back the greater part of the heat, almost as if it were additional hot fuel in the fire, and thereby nearly doubles the warmth felt in directions away from the surface.

Neither does common observation make persons aware of the truth, that of the heat produced by combustion in a common fire, one part—being somewhat more than half—is diffused, like the light, by radiation, into the open space around, and the remainder is given, by contact and conduction, to the air which supports the combustion, and to the solid material of the fire-place. Thus, with a common open fire-place, it is the radiant heat almost alone which warms the room, the remainder either at once combining with the burned air or smoke, and passing up the chimney, or being given by the heated grate to pure air, which touches that, then passing into the chimney with the smoke.

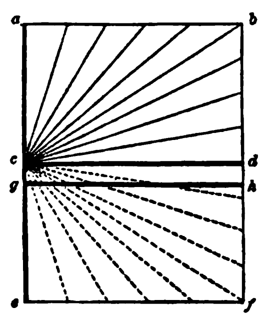
And, lastly, many persons do not at first learn the truth, that the rays of heat passing through pure or transparent air do not at all warm that air, but warm only the solid or opaque bodies by which the rays are intercepted, and that thus the air of a room is warmed only at second-hand, by contact with the solid walls and furniture which, having intercepted the heat-rays have themselves first become heated. Yet most educated persons know similar facts, such as that the sunbeams, bringing both light and heat to the earth, as they descend to warm the hottest valleys or plains of the earth, pass through the upper strata of the atmosphere, which are always of a temperature much below freezing. This is proved by the fact that all lofty mountains, even under the equator, are capped with never-melting snows, and that the higher the peaks are—and, therefore, the nearer to the sun—the colder they are. Thus, also, all persons who have attended to the subject know that aeronauts, in their balloon-car, if they mount very high, would be frozen to death but that they are protected by very warm clothing. Another fact of the same kind is, that a glass globe, filled with cold water, or even ice, may in the sun's rays be used as a burning-lens.

These explanations being premised, the two popular delusions respecting the low fires become at once apparent.

1st. The supposition that fuel burnt in a low fire gives out more heat, has arisen from the experimenter not reflecting that his hand held over the low fire feels not only the heat radiated from the fire itself, but also that reflected from the hearth close beneath it, which second portion, if the grate were high, would have room to spread or radiate downwards and outwards to the more distant floor or carpet, and to warm them.

2nd. The notion that the fire, because near the floor, must warm the carpet more, springs from what may be called an error in the logic of the reasoner, who is assuming that the hearth, floor, and carpet, being parts of the same level, are in the same predicament—the truth being, however, that in such a case the portion of the hearth which is within the fender gets nearly all the downward rays, and the carpet almost none—as a candle held before a looking-glass at a moderate distance diffuses its heat pretty uniformly over the whole, but if moved close to one part of the glass it overheats, and probably cracks that part, leaving the rest unaffected. A low fire on a heated hearth is to the general floor or carpet of a room nearly what the sun, at the moment of rising or setting, is to the surface of a field. The rays are nearly all shooting upwards from the surface, and the few which approach it slant obliquely along, or nearly parallel to, the surface, without touching, and therefore without warming it.

The annexed diagram serves to elucidate these facts. *c*, represents the fire-place or centre of radiation, with rays diverging from it into all free space around; *a c*, the wall in which the grate is set, and which can receive none of the direct rays,—as is nearly true of the floor also if the fire be on the hearth; *a b*, the ceiling; *b d*, the wall opposite the fire; *c d*, the floor, with the fire on or close to the hearth. If there were no floor at all, these rays would shoot as abundantly down to the bottom and walls of the room below, as to the ceiling and walls of the room above; but the hearth-stone of the floor *c d*, first intercepts all the inferior rays, and then radiates them up to the ceiling, leaving the floor unsupplied unless by secondary radiation from the ceiling and walls. *g h*, represents a floor at a moderate distance below the fire. It is seen, by where the ray-lines intersect this floor, that much of the heat of the fire must spread over it, and chiefly between the middle of the room and the grate where the rug is, and where the feet of the persons forming the fireside circle are placed.




Striking proof of the facts here set forth is obtained by laying thermometers on the floors of a room with a low fire, and of a room with a fire, as usual of old, at a height of about 15 or 16 inches above the hearth. An experiment tried in two such rooms, in both of which thermometers on the pianofortes, 4 feet above the floor; stood at 62°, showed the carpet, not far from the hearth, to be at 56° with the low, and at 73° with the high fire.

As would be anticipated by a person understanding the subject aright, low fires make cold feet very common, unless to those who sit near the fire with their feet on the fender; but deceived by their fallacious reasoning, the advocates are disposed to blame the state of their health or the weather as the cause, and they rejoice at having the low fire, which can quickly warm their feet when placed near it. A company of such persons seen sitting close around their fire with thankfulness for its warmth near their feet, might suggest the case of a party of good-natured people duped out of their property by a swindler, and afterwards gratefully accepting as charity from him a part of their own property.

Many persons have been prevented from detecting the truths connected with low fires by the fact, that where the chimney breast or opening is also made low, the mass or stratum of comparatively stagnant warm air in the room is deeper or descends lower than where the chimney opening is high, and the room thus arranged may be, except near the floor, warmer than before. But advantage from this arrangement is often missed by the chimney throat being left too wide, causing strong cold draughts below, and where there are many persons in the room, the possible good is more than counterbalanced by the ventilation above being rendered in proportion more faulty. In the new smokeless grate, there is the advantage of a low chimney opening, although with a high fire, and yet the ventilation is maintained perfect for any amount of crowd by the ventilating valve, placed near the ceiling of the room.

* The subject of this article was referred to by Dr. Arnott, at the Society of Arts, during the reading of his paper on the Smoke-Consuming Fire-grate, on the 10th May last (see *Journal*, *ante* p. 201); and as it has been deemed important, he has since given his remarks in writing (for publication in the Society's Journal), which may be taken as forming part of his original paper.

It may be observed here, that the smoke-consuming grate exhibited in the Hall of the Society of Arts, is of small size, fitted for a room of moderate dimensions, and was originally intended to be placed for inspection on the table, merely to show the principle, but the Secretary, judging that it would be more interesting if seen in action, desired it, although so disproportionate, to be fixed for the time in the fire-place of the large Hall. That grate was constructed by Messrs. Bailey, of Holborn, but the deviser hopes, as the whole arrangement is so simple, that intelligent manfacturers everywhere will be able to make it perfectly. He deems himself bound to publish soon, any further instruction with regard to it, which further and more varied experience may suggest.

## ON ARCHITECTURE AS REPRESENTED IN PICTURES.

By Henry Twining.

[*Paper read at the Royal Institute of British Architects, June 12th.*]

Pictures exhibit, in a convenient manner for study, the different styles of architecture in direct connection with different kinds of scenery. As we are thus enabled to appreciate the relation of architectural buildings to the climate and character of different countries, we have great facility in selecting those styles or orders of architecture which are best adapted to the scenery, as well as the climate and conditions of our own country. Moreover the architecture which adorns pictures is exempt from those trammels which considerations of economy and site, and other hindrances, impose on the work of the architect; and it therefore possesses every facility and advantage for realising the kind of edifice which, in the mind of the artist, appears most consistent and becoming.

As the kind of embellishment which architecture supplies for historical pictures was more resorted to formerly, than at the present time, it is by considering the old masters that interesting facts may be chiefly elicited. One of the most striking points in connection with this subject is, that architecture seems to have been generally treated by them as a somewhat conventional ornament, adapted to the effect of the picture, but without reference either to the country, or to the period of the event represented. The style of architecture most usually selected was the classic, which is frequently brought into connection with events taken from the Scriptures, and which therefore occurred chiefly in Judea. But notwithstanding the impropriety of introducing the classic style of architecture into subjects which are entirely Eastern, the association of the simpler orders of such architecture with scriptural subjects does not strike so offensively as might be expected, a proof, it may be considered, that this style is remarkable for its great purity, and for its suitableness for all dignified or elevated subjects. It would be difficult to believe that the Saracenic, the Renaissance, or any other elaborate style of architecture, could by any contrivance be made to associate with events so solemn, and at the same time so decidedly local, as those which are borrowed from Scripture.

Rafaelle was one of the Italian masters who had most recourse to architecture for the embellishment of his pictures; and although he did not always avoid the inconsistencies and anachronisms which contemporary artists were apt to commit, he showed an attention to circumstantial facts and particulars which very few equalled. One of the earliest and most beautiful of his works, known as "The Marriage of the Virgin Mary," now in the gallery of Milan, is adorned by an elegant building of sixteen sides with Ionic columns, probably intended for a synagogue, but not having anything Eastern in its style. Its appearance has however nothing offensive, but affords a pleasing accessory to this beautiful subject. In his painting of "Paul and Barnabas at Lystra," this great artist has shown the same attention to circumstantial details, and with the happiest results; for amongst the statues which decorate noble edifices, the statue of Mercury appears conspicuous, reminding the observer, at once, that the inhabitants believed St. Paul himself to be that God; and that they were about to offer sacrifice to him as such; it is plain how much the historical account is elucidated by such particulars. "St. Paul preaching at the Areopagus at Athens," likewise affords a successful proof how much Rafaelle enhanced the beauty of his historical pictures by means of tasteful architectural buildings, of which the classic orders, clearly defined, are perfectly and appropriately characteristic. In another picture (of which the cartoon is at Hampton Court) representing St. Peter and St. John healing the lame man at the gate of the temple which was called "Beautiful," he has introduced a number of spiral columns, richly and elaborately decorated, by which means he has marked impressively the characteristic splendour of the porch. But in this instance his attention to particulars does not appear to have been equally successful, for the effect is meretricious, and detracts from the solemnity of the subject. A simpler style of architecture, though perhaps less truthful, might have been better suited to the dignity of the composition.

Neither Michael Angelo nor Leonardo da Vinci, although the first was an architect, and the second an engineer, seems to have resorted much to architecture for the embellishment of their pictures. Nor did Correggio, who at Parma contributed so much by his frescoes to embellish the Duomo, avail himself of the beauties of architecture to enrich his most graceful subjects. The Venetian school of painting, however, borrowed a great deal from the sister art; and in this we may probably mark the influence of the architectural magnificence of the city.

Gentile Bellini was one of the earliest masters who painted architectural subjects; and during his residence at Constantinople he executed a large, and, at the same time, elaborate and highly finished picture of the church of Santa Sophia, which is now in the gallery of Milan.

Another picture of the Venetian school, very remarkable for its architectural interest, represents what was termed the "Miracle of the Ring," so famous in the Venetian annals. It was painted by Paris Bordone, and the background represents the beautiful and highly decorative architecture of the Palazzo Ducale almost as it now stands. But the artist of this school who gave the greatest importance to architectural ornament in his pictures was Paul Veronese. By the introduction of architectural monuments on a large scale he imparted great beauty and originality to his pictures. He often gave perspective depth and greatness to his compositions by representing these edifices at various distances. Further, by placing them on the most diversified situations he added in a remarkable degree to their picturesqueness. These architectural arrangements afforded him the means of diversifying the positions and attitudes of his figures, which he represented alternately ascending flights of steps, leaning over elevated balconies, or climbing up buildings, in order to overlook the principal scene of action.

The Dutch and Flemish, as well as the French painters, usually showed the same disregard for a style of architecture in accordance with Eastern subjects, as did the Italians. For instance, Rubens, notwithstanding his extensive information, and his high position in society, introduced the Doric order of architecture in connection with "The Murder of the Innocents." Nicholas Poussin, who largely availed himself of the advantages afforded by architecture, introduced columns, apparently of the Corinthian or Ionic orders, in paintings of David and Goliath. "The Murder of the Innocents" by Le Brun, now in the gallery at Dulwich, is likewise enriched by edifices of Roman structure, having columns of the Corinthian order. We might have expected rather more antiquarian knowledge or attention to facts, from so eminent and comparatively modern an artist.

But it is especially as an embellishment to the landscape that architecture attains the highest value, and often ennobles scenes which without such ornaments would appear tame or trival.

Among the landscape painters, Claude de Lorraine availed himself most effectually of the resources which architectural subjects afford; and by the frequent introduction of temples, arcades, palaces, and other buildings, into his landscapes, he imparted to them an elegance, and an air of classic dignity, which it would perhaps have been impossible to attain without the elevating influence of this class of accessories.

The two Poussins were especially fond of that kind of embellishment which is furnished by architecture; and Gaspar Poussin, who was essentially a landscape painter, added by such means greatly to the interest and character of his landscapes. For instance, he marked the strength of any lofty situation by walls and fortifications; the particular aptitude of any site for being inhabited by a large and populous city; and the loneliness of a retired spot by tombs, obelisks, and mausoleums. He thus stamped more impressively the local character of each subject.

The Dutch landscape painters, as Poelemburgh, Berghem, and Loutherburgh, introduced buildings and monuments chiefly as ruins, in which forlorn, but venerable condition, these greatly enhanced their small pictures. But there is a class of artists, who instead of making architectural buildings serve as an ornament to their landscapes, completely spoilt their compositions by great abuse of the resources which it affords. Amongst these may be mentioned, Marco Ricci, Lingelbach, and sometimes Pannini. They availed themselves of their sojourn in Rome to copy the numerous monuments of various periods which there abound. This they did, however, without taste and discernment; and in their pictures they introduced promiscuously, and in the greatest confusion, monuments of different periods, of different styles of architecture, indeed of the most opposite character, accumulating these incongruous elements with a confused profusion of which Rome itself does not afford an example. In some instances they rendered this heterogeneous assemblage more ludicrous by intermingling figures of different dates and costumes with the ruins.

Modern landscape painters have devoted themselves more exclusively to nature herself, and have availed themselves generally in a less degree of such means of embellishment as architectural buildings afford. However, the French marine artist of the last century, Joseph Vernet, introduced architectural buildings, especially lighthouses, bridges, and aqueducts, with great taste and effect; and his English contemporary, Wilson, realised corresponding advantages by the ruins of such monuments. I need not remark that the late Turner, when not led by the fascinations of colour to neglect the resources of ornamental form, availed himself most advantageously of the decorative beauty of architecture in his landscapes, as may be seen by the grace and elegance which his picture representing "The Building of Carthage" derives from its architectural monuments. We are aware that John Martin so completely commanded the resources of architecture that he thereby imparted a character of combined splendour and vastness to his compositions. In some of his pictures ancient cities surprise the observer by their extent, their remarkable situation, and the originality of the buildings. In others, as in "The Feast of Belshazzar," it is the magnitude of the palaces, and other edifices, which causes our admiration. In these subjects a style of architecture has been adopted, which though to some extent ideal, at least carries the mind at once to the time and the place of the event recorded, an attempt which had not been made by the landscape painters of olden times; and which, although till lately quite new in this branch of art, Martin carried out with the most complete success.

In the course of the discussion which ensued, Mr. Donaldson said he considered that the painters who had introduced architectural subjects into their pictures might be divided into two classes: the first were real painters of buildings, such as Canaletto and Panini; the others, as Raffaele, treated architecture merely in the light of an accessory, and to give contrast, by the repose of the structural masses, to the violent action and bustle of the figures. The Venetian School afforded good examples of the second class. It was obvious that though Raffaele had exercised great thought and discretion in such accessories, he had committed some incongruities, as in representing strictly Roman architecture in buildings forming the background of the cartoon of St. Paul preaching at Athens. The introduction of architectural subjects into pictures might naturally have taken place in a city like Rome, abounding in ancient remains, which would work on the imagination of the great men composing the brotherhood of practitioners in art which existed there in the fifteenth century. Michael Angelo was an architect by accident —painting and sculpture were more especially his forte,—and his particular case, Mr. Donaldson would adduce as a reason why he entirely disagreed with Mr. Ruskin as to painter-architects alone deserving the palm of excellence; Palladio, Sanmichele, and Brunelleschi, on the contrary, were highly successful as architects,—great play of contrasts was exhibited in their works —but they were not painters. The Beautiful Gate of the Temple shown in one of the cartoons, might perhaps have been more correctly shown with columns of Egyptian character; but it might be supposed that Raffaele was himself ignorant of the real architecture of the place which he had undertaken to represent. Claude, on the contrary, introduced subjects taken from Italian ruins; finely grouped, and with great propriety, into his landscapes, and his example had been followed by our countryman Turner, who, by desiring to have one of his pictures hung between two by Claude, in the National Gallery, had evidently implied the estimate on which he set his own painting; and yet it should be remembered that Turner had accomplished no more than Claude had between 200 and 300 years previously, without any predecessor to instruct him, from whose productions he could obtain hints, and learn to avoid errors. To Claude, innate taste and the study of nature had alone been assistants. The value to a painter of having seen and studied the ancient remains in Italy might be seen in the productions of Wilson the landscape painter. The training necessary to render an artist a good scene painter, in respect to treating architectural subjects with strict correctness, had produced good landscape painters in the persons of Stanfield and Roberts. The views of Daniell on the walls afforded a great lesson in the happy manner in which Indian architecture was composed and grouped to harmonise in all respects with nature—the deep shady verandahs and colonnades, surrounded by groves, and enlivened by cool fountains and glittering minarets, vieing, as it were, with the beauty of the Eastern climate.

## THE GENERAL BOARD OF HEALTH.

*Letter to* Viscount Palmerston, *in reply to the Report of the General Board of Health, on the Administration of the Public Health Act, and the Nuisances Removal and Diseases Prevention Act, from* 1848 *to* 1854.

My Lord—The members of the General Board of Health have lately published a Report of the manner in which they have administered the powers conferred upon them by the Public Health Act, and the Nuisances Removal and Diseases Prevention Act; and they have pointedly alluded to some of the scientific principles and administrative measures they have endeavoured to introduce. All the best qualified English engineers are, my lord, decidedly opposed to the application of the principles and the measures in question; because, from long study and practical experience, they find the former to be in contradiction with the facts observed by the most eminent authorities, and the latter they hold to be of an unconstitutional tendency. In common with the rest of the public they had, however, hoped that the present Session would not have been allowed to pass over without a full and deliberate investigation into the conduct of the new and as yet irresponsible branch of public administration created for the express purpose of carrying the above-cited Acts into effect, and had, therefore, refrained from taking any decisive steps to record their opinions. But as the Session has advanced to a late period, and it is not possible now to procure the investigation of a subject so complicated, and so important, in time to enable the legislature to act effectually upon the results of the proposed inquiry, it is to be feared that the only course which may be adopted may simply be to renew the existing powers of the existing General Board of Health. Entertaining in common with my brother engineers the opinions above stated, I have considered it to be my duty to address to your lordship a few remarks on what appeared to us to be the mistaken opinions, and questionable conduct of the acting members of the General Board of Health, with the hope that your lordship would adopt, before it is too late, such measures as should enable you to form more correct opinions on the subject than can be arrived at by following exclusively the inspiration of the advocates or the opponents of any absolute system.

In presenting these remarks to your lordship, I would expressly state that it is my intention to confine them to measures, and to avoid as far as possible allusion to men. It is, indeed, with pain, that I feel myself obliged to differ in opinion from the Earl of Shaftesbury, even upon matters of abstract science, so high is my estimation of the conscientious integrity with which he has adopted his conclusions, and of the pure and noble motives which induce him to accept the responsibility of the proceedings he has lately been connected with. When the public welfare is at stake such considerations of private delicacy must, however, be waived; and I am sure that Lord Shaftesbury himself will be the first to call for the inquiry I suggest, when he discovers that the opinions of the persons who have hitherto guided his official conduct in the administration of the Public Health Act, are entirely different from those of parties more competent to judge than they can possibly be, and whose experience has convinced them that the opponents of the technical details enforced by the General Board of Health have been justified in their conclusions by the practical results already obtained.

The principal reason cited by the General Board of Health as an attempted explanation of the course it has pursued, and as an argument for the necessity of a prolongation of its powers, is to be found in the assertion, that the ravages of the Asiatic cholera have been materially attenuated by the measures it has introduced. This is scarcely so, for unfortunately it would appear that the circumstances under which this fell disease operates, and the means of arresting its course, are as little known now as they were when it first appeared amongst us. The causes, to which it has been the fashion of late to attribute the development of the scourge, had been in operation from the earliest periods of our history to 1831, without producing the same results they are now said infallibly to occasion. The College of Physicians and the General Board of Health entertain views upon the diffusion of Cholera which are essentially different, for the latter persist in calling it an epidemic, whilst the former assert that human intercourse (*i.e.* contagion) has much to do with its diffusion. The General Board of Health prophecy a return of the disease this year—the College of Physicians show that nothing is known of a nature to warrant any *a priori* reasoning upon the subject. As it is, however, ascertained that *fear is a great predisposer to the disease*, we may fairly question the policy of the General Board of Health in thus maintaining in the public mind a constant and injurious state of alarm. With respect to the remedial measures it suggests, they are precisely the same as were recommended in 1832, and have been carried into effect by private persons, often at the risk of health and life, without any attempt to exaggerate the importance of their sacrifice. The General Board of Health has not discovered one new fact connected with this unaccountable visitation, nor has it proposed any one practical measure for its alleviation. Vague declamations upon the advantages of cleanliness, and the necessity for drainage, can hardly be considered merits in the country in which it is proverbially held that "Cleanliness is next to Godliness."

The objects for which the General Board of Health was established were avowedly to advance the execution of every description of sanitary works, but the Report shows that not only have many collateral investigations been allowed to divert its attention from its immediate duties, but that where it has operated, its proceedings have been arbitrary and obstructive. The subjects of Quarantine, of Interments, of Water Supply, &c., have in their turns, occupied the time, attention, and energy of the Board, although irrelevant to the duties for which they had been appointed.

What has been said with respect to the uncertainty overshadowing the origin and progress of the Cholera should make us pause before we admit the full extent of the value of the report on Quarantine; and indeed, notwithstanding the translation of this document into foreign languages, and its liberal distribution, doubtlessly at our expense, it is curious to observe that no foreign government has adopted the recommendations of that report. It is singular, too, that the Belgian Government should have lately issued a decree by which the sewerage of the towns of that kingdom is to be dealt with upon principles diametrically opposed to those recommended by Mr. F. O. Ward, whom we may suppose to have been the authorised representative of the General Board of Health, at the Sanitary Congress, lately held in Brussels. Evidently foreign authorities pay but little attention to our asserted new lights in matters of Engineering, or Sanitary, science.

But the most startling fact in the report of the General Board of Health is that is should dwell with somewhat of satisfaction upon its conduct in the case of the Metropolitan Interments Act, a more striking failure than which could not possibly be imagined. Many conscientious and able persons are disposed to question the propriety of state intervention in these details of domestic and private interest. Even on the Continent, from whence the General Board of Health drew its examples, the arrangements for the disposal of the remains of departed mortality are left to the care of municipalities. In no case does the Central Government intervene. If the State once undertakes to dispose of the bodies of the dead, there seems to be no reason why it should not also provide for the bodies of the living. Food should, on such principles be no more a subject of commercial speculation and profit than interments, and in the logical application of these doctrines society would become a general "Phalanstere." But if the abstract question be passed over, the fact will still remain that the, by them regretted, Metropolitan Interment Act was a complete failure.

A short history of this remarkable transaction, as it appears to the world, is as follows:—The scheme for the Metropolitan Interments had become law in spite of the opposition of the cemetery companies, and, as might have been expected, these latter declined treating by agreement with the General Board of Health when it became necessary to obtain possession of their grounds. The Board, after uselessly negociating and intriguing with some of the companies, was therefore compelled to give notice, under the provisions of the Metropolitan Interment Act, of their intention to take by compulsion the Brompton (or Westminster), and the Nunhead Cemeteries. In both these cases, the respective parties proceeded to determine the value by reference, and on receiving the award of Mr. Peacock, the eminent barrister, the General Board of Health desired to abandon the purchase, offering to pay all the heavy expenses incurred. This offer was refused by the Westminster Company, and it held the General Board to the terms of the award; but the Nunhead Company let the Board off its bargain, on the payment of at least 1000*l*. The price paid for the Westminster Cemetery was 74,921*l*., its annual maintenance is about 4000*l*., and it may fairly be considered to be a burthen upon the nation of the most useless and expensive nature.

So glaring indeed was the failure of the General Board of Health in the matter of the Metropolitan Interments, that Lord John Russell's government was forced to bring in a bill to remedy the mischief it had produced. Yet we find that the Board still casts a look of affection on its own abortive scheme, and cites its labours in this case as one of its excuses for having neglected its legitimate duties!

Hardly less unaccountable is the reference to the inquiry into the "New Sources of Water for the Metropolis, and new modes for its collection." The investigations before the Committees of the House of Commons, 1851 and 1852, must have enabled any unprejudiced person to discover that the sources proposed by the Officers of the Board could not yield the quantity of water required, and that the cost of conveying what could be so procured must be immeasurably in excess of the estimates presented. The results lately obtained at Sandgate and Rugby prove that these new modes of collection are open to serious, if not fatal, objections; whilst the recommendations of the Chemical Commission, composed of Messrs. Graham, Hoffman, and Miller, show that the waters now supplied to the Metropolis, so far from being objectionable, are, when properly filtered, of a superior quality. Their express words are:—"When in good condition the Thames water possesses the peculiar and agreeable brightness of chalk waters, arising from absence of colour, combined also usually with good aëration." "The Thames water may be described to be in circumstances not unfavourable to purity and coolness, a palatable water. *The amount and nature of its saline constituents, probably contribute to its general acceptability as a beverage.*" So that it would appear from the only impartial investigations which have been made in the matter, that the effect of the adoption of the recommendations of the General Board of Health in this case would have been to have involved the Metropolis in an incalculable outlay without any resulting benefit.

The General Board brings forward no valid arguments in favour of its own water theory, for the asserted savings in tea and soap from the use of soft water have been over and over again shown to be ridiculously exaggerated. But having accused all former professors and professional men of ignorance, it was of course necessary for the Board to start something new on its own account. Hence the scheme for obtaining soft water by means of underground drainage from gathering grounds: a scheme which may have the merit of novelty, but which experience has already shown to possess nothing else to recommend it. For at Rugby, and Sandgate, this favourite system of the Board of Health has entirely failed to secure either a good or a copious supply. It is therefore to be hoped that the interests of the Metropolis will not be again risked in the hands of persons so rash, so desirous of novelty, so inexperienced, so self-confident, and so self-laudatory.

Notwithstanding, however, the express terms of the report of the Chemical Commissioners, the General Board of Health repeat their conclusion, "that the Thames water is inferior as a supply for domestic uses on account of its excessive hardness." This might arrive from a pre-conceived or from a mistaken view of the philosophical question raised by themselves. But when the Board of Health publishes in 1854, that "the water taken by the Lambeth Company from the Thames, opposite Hungerford Market" is impure &c., it asserts what is positively untrue, what anybody might ascertain to be incorrect, and is manifestly guilty of wilful unfairness. *For more than two years not one drop of water has been pumped by the Lambeth Company from this source.*

In the letter which your lordship addressed to the Metropolitan Commissioners of Sewers, when you forwarded to them the communication you had received from Mr. F. O. Ward, your lordship expressed your concurrence in the views entertained by the General Board of Health, on the subjects of combined back drainage, and (the so-called) self cleansing pipe sewers, in opposition to (the so-styled) sewers of deposit. It was with considerable regret that members of the engineering profession observed that your lordship had thus appeared to have decided a physical question upon which the practical and theoretical Boards were respectively at variance, and they had hoped that the delay which has taken place in the construction of a New Board for the Metropolitan Sewers, indicated the intention of a further investigation of so important a subject. Such a course ought still to be adopted, but as was before said, it is to be feared that the session is too far advanced for any efficient inquiry before a select committee of the House. I would, however, respectfully protest against the substitution of any of the unsatisfactory and unconstitutional modes of investigation lately adopted. Before Royal Commissions, witnesses are examined in private, are not necessarily cross examined, the whole of the proceedings are not published, and it too often happens that only such evidence is taken as happens to suit that purpose of the leaders of the movement which has led to the inquiry. The great amount of property, and the immense number of persons to be affected by the conclusions to be arrived at, render it more than usually essential that the greatest possible degree of attention and impartiality should be brought to bear upon the investigations.

My lord, the greatest errors which can possibly be made in reasoning upon questions of engineering, arise from the acceptance of verbal formulæ for admitted facts,—the belief that limited laws are of invariable and inflexible application, and that a name is a veritable personification of a thing. It appears to many able persons that the Board of Health *does* commit all these errors. It calls pipe sewers "self cleansing," and brick sewers "sewers of deposit." But unless the former are well laid, with considerable inclinations, and receive an abundant supply of water, they cannot be *kept clean*: in no case whatever can they act to cleanse themselves. The phrase applied to pipe sewers is a mere clap-trap, as false in philosophy as it is incorrect in grammar. So with respect to brick sewers, they are by no means necessarily "sewers of deposit;" since it is notorious that, when properly executed, they can be kept cleaner than the others, and they certainly allow of being examined and repaired with greater facility. Indeed the results obtained at Croydon, Dartford, Morpeth, the Metropolitan Districts, and in the towns examined by Mr. Bazalgette, show that the pipe sewers are as often "sewers of deposit" as the ordinary brick ones. The application of a name does not indeed, my lord, prove a fact.

With respect to the combined back drainage, it is not denied that it *may* be preferable in some exceptional cases to other modes of laying sewers, but it certainly is not so in all, nor in many. In the case of the Metropolis, and all other large cities and towns, it is particularly objectionable, because the character of house property is continually changing; and it is practicably impossible to apply a system which exposes the inhabitants of a whole row of houses to be seriously inconvenienced by the whims, or carelessness, of the dwellers in one. The houses with gardens at the back this year, may be required to be converted or enlarged in the next: but if the combined back drainage has been executed this would be impossible, because the land over the drains would have become public or common property. As already said, in some cases this system may be applied. He who rejects it altogther is therefore exposed to find himself as much in the wrong as he who applies it indiscriminately. But it must be observed, that ordinary engineers had, long before the establishment of the General Board, been aware of this fact, and had exercised their discretion as to when to use, and when to avoid, combined back drainage. It required the erection of a New Court of abstract theorists to endeavour to enforce the universal adoption of a law which was in itself only partially and incidently correct.

The active members of the General Board of Health have perhaps done more mischief by the promulgation of their dogmas with respect to the size of pipe sewers than by any other of their proceedings. In the earliest period of their activity they enforced, literally *enforced*, the use of 4-inch pipe sewers to houses, and even, as at Croydon, in streets; and in that most astounding document—the report of the Trial Works Committee, they positively stated as the ground for this rule "that one gallon of water, through a 3-inch pipe, moved 1 lb.; through a 4-inch pipe, it moved 3 lb.: through a 6-inch pipe ½ lb. barely;" and a little further on it appears "that" (according to the Trial Works Committee) "an increase of inclination beyond 1 in 60 offers less advantage than has been commonly attributed to it." This reasoning is mere nonsense, my lord, and the experiments on which it was founded, although they cost the metropolitan public the sum of 5000*l*., were utterly worthless, because made by men who had no science, and could not observe. The results derived by the Board from both reasoning and experiments were in opposition to the laws of nature, and to the practical and scientific knowledge of all engineers of every nation. The application of the law so propounded, has led to the miserable failures to be met with throughout England. Surely men who could so rashly promulgate an impracticable theory; and enforce its application by a very unjust and tyrannical pressure on country towns, have but an ill grace when they accuse of empiricism those who differ from them, and still more, when they endeavour to shift the ground of the objections to their theories by applying names intended to provoke ridicule. A 4-inch pipe drain will not, my lord, suffice to carry off the sewerage of an average house; combined back drainage is decidedly objectionable in most cases; it is more advisable to resort to good river waters than to try new-fangled schemes of pot-piped gathering grounds, &c.; and a public body, or even a private individual, may reasonably object to the forcible application of any of these dogmas without being on that account *a lover of dirt*.

One illustration more of the incorrect assertions and the dangerously-distorted statements of the General Board of Health.

In the Report under consideration, the General Board of Health assert that upon the average, the cost of the water supply brought to every house in the towns where works have already been completed under its superintendence, has been about 1½*d*. per week; and that of main or sewer drainage (which, be it observed, is *rarely* brought to the houses, although the contrary is asserted in the Report) has been about 1*d*. per week. But it appears from Mr. Bazalgette's Report on the towns especially cited by the Board of Health, as having been supplied to its satisfaction, that the cost of the public works per house has been on the average rather more than 16*l*., whilst the private works have varied from 5*l*. to 50*l*. Assuming, however, that the whole cost is, in towns of magnitude, only 20*l*. per house, the average annual rate to pay the interest on the capital, and to form a sinking fund to be invested at compound interest at 5 per cent. must be 130,102*l*. per annum, or 6*d*. per week, and then the cost of maintenance, repairs, working staff, &c. must be added. If we take the case of a poor class of house, instead of a house of the average size, nearly the same result is found to occur. Thus, to quote only two of the instances selected by the Board itself as proving the superiority of its mode of action: at Rugby, where the special rate is 10*d*. in the pound for public works, and 4*d*. in the pound to consumers, the annual charge without any reference to the cost of the private works is upon a cottage rated at 10*l*. per annum, 11*s*. 8*d*., and if the interest and sinking fund for the private works be added, this becomes 17*s*. 11*d*. per annum, or above 4*d*. per week. At Sandgate, the water rate is 1*s*. in the pound, and the sewers rate 6*d*. in the pound, so that adding for the private works as before, the charge to a 10*l*. cottage would be at least 1*l*. 1*s*. 3*d*. per annum, or very nearly 5*d*. per week. In each of these there is a further payment to be made to the General District Rate.

As these instances are by no means exceptional, we are compelled to arrive at the conclusion, that the assertion of the General Board of Health, that the public and private works connected with drainage and water supply can be, or have been, executed in such a manner as to allow an average rating of 3½*d*. per house per week, is not correct. Your lordship has, indeed, only to read carefully Mr. Bazalgette's Report, to be convinced of the inaccuracy of the statement.

My lord, I have not yet touched upon the constitution and action of the General Board. These important topics must be reserved for a further communication; but for the present I conclude, by earnestly intreating your lordship to examine for yourself, with the aid of competent advice, both the doctrines and the practice of that unpopular authority.

GEO. R. BURNELL, C.E.

14, *Lincoln's-inn-fields, July 18th*, 1854.

## BRADFORD DRAINAGE AND SEWAGE.

THE Street and Drainage Committee of the town of Bradford having commissioned Mr. E. W. Shaw, the Borough Surveyor, to report upon the sewage requirements of the town, we are glad to find that he has determined on effectually and permanently providing for the thorough drainage of that rapidly-increasing district, instead of tampering with the question, as is too frequently the case, by proposing a complicated system of pipe sewers.

After a careful survey, Mr. Shaw proposes to construct a main trunk sewer, to run through the town and discharge itself temporarily into the Beck, until the requirements of the district demand its extension, or means are adopted to apply the sewage as a fertiliser. Mr. Shaw states that there is ample evidence in the state of the various brooks and of the canal, which intersect the town in different directions, to demonstrate that this question is of paramount importance; however bad the state of the streams may be, yet there is a far greater evil in existence—not the less an evil because unseen—viz., the complete saturation of the subsoil of the town with sewage matter which is now taking place. This is partly owing to the present sewers being constructed of rubble wallstone without lime, partly to many of these sewers being without outfalls, and lastly, to the vicious plan frequently adopted of constructing these sewers so as to take advantage of the numerous fissures in the rock formation, to allow the sewage water to escape through or rather into them.

In laying out the main trunk sewer, Mr. Shaw has kept in view the following principles necessary to a proper system of sewerage, and which are applicable to the construction of sewers generally:—

First. That the shortest practicable route be obtained for the main trunk sewer, and that all unnecessary angles be avoided.

Secondly. That the outfall and level of the sewer be so arranged as to secure the effectual under-drainage of every building within the district, and admit of the branch sewers being laid at such rates of inclination as to secure a rapid flow of water through them.

Thirdly. That the rate of inclination of the sewer be such as will prevent any deposit from taking place within it, and consequently ensure the constant motion of its contents, thereby avoiding, to a considerable extent, the evil effects of allowing decomposition to take place in the sewer.

Fourthly. That the form of the sewer be that which will afford the greatest amount of resistance to the external pressure of the soil in which it is placed, and the least amount of resistance to the flow of water within it; and at the same time that which requires the least quantity of material in its construction.

Fifthly. That the size of the sewer be of sufficient capacity to carry off the sewage water, surface drainage, and underground springs; and be gradually increased in size at the various junctions of the principal branch sewers, sufficient for the purpose, without such excess of capacity as would retard the current passing through it.

Sixthly. That the sewer be constructed of such materials as will present the smoothest possible surface for the passage of the water, and will at the same time prevent any of the liquid within it from percolating through the structure.

Seventhly. That all inlets into the sewer be effectually trapped, and that a thorough system of ventilation be adopted and carried out.

Eighthly. That all junctions with the sewer be made with curves of as large radii as possible in the direction of the current.

Ninthly. That the sewage be so disposed of that it will not pollute the streams or rivers in its vicinity, nor vitiate the atmosphere, but so as to be applied to the useful purpose of increasing the fertility of the agricultural districts.

Tenthly. That the sewer be enduring in its character, and not liable to require reconstruction during the course of a generation.

In selecting the route for this main trunk sewer, little difficulty has been experienced, owing to the peculiarly favourable nature of the district. The main valley line has been selected as far as Mr. Gath's warehouse, in Bridge-street, where it is proposed that the line shall leave the valley of the Bradford Beck, and then traverse that of the Bowling Beck. This is proposed in order to relieve a large and densely-populated district without the immediate necessity of any other works being constructed, excepting the temporary connection of the present sewers in the streets diverging from Manchester-road. The total length will be about 13,720 feet, or near 2⅗ miles. The curves are all remarkably easy; having radii extending from 350 to 800 feet.

The depth at which the sewer is placed is in some cases rather considerable; this is the case where it passes under Bolton-lane. Several causes have contributed to the necessity for thus placing the sewer—amongst others, the desirability of avoiding its passage through private lands—the situation of the new works of the gas company, and the risk of meeting with a large quantity of water in the gravel-beds had the sewer been diverted more to the east. Under all the circumstances, the proposed line is the most economical, and it has the further advantage of securing the most direct course and the avoidance of angles.

The nature of the district admits of a very rapid fall being given to the bottom of the sewer, securing a great velocity of water, and consequently a scouring effect, which will effectually prevent any subsidence from taking place; and it will be observed from the following statement, that the rate of inclination increases as the area to be drained, and consequently the bulk of water to be removed, diminishes—thus complying with the well-known law, that hydraulic depth compensates for want of declivity, and on the other hand, declivity compensates for the want of hydraulic depth.

The lengths of sewer at the various rates of inclination are as follows:—1 in 250 for 2660 feet, draining an area of 2091 A. 2 R. 10 P.; 1 in 185 for 5370 feet, draining an area of 1897 A. 1 R. 6 P.; 1 in 60 for 2600 feet, draining an area of 322 A. 29 P.; 1 in 30 for 3090 feet, draining an area of 182 A. 1 R. 21 P.

These rates of inclination contrast favourably with the trunk sewer at Leeds, which has a fall of 1 in 792; the King's Scholars' Pond sewer, London, which falls 1 in 2400; the central sewer, Preston, which falls 1 in 800; and the proposed northern intercepting sewer, London (Mr. Bazalgette's scheme, approved by Sir W. Cubitt and Mr. R. Stephenson, M.P.), which falls 1 in 2460.

It appears from experiments by Dr. Robinson, that a velocity of 180 feet per minute will remove angular stones the size of an egg. This is confirmed by Mr. Phillips, under the Metropolitan Commissioners of Sewers, who states that a constant flow of 2½ feet per second, or 150 feet per minute, is sufficient to prevent soil depositing in the sewers; in no portion of this proposed main trunk sewer will the velocity be less than 400 feet per minute when the sewer is full or half full; therefore all cause of uneasiness respecting the silting up of the sewer may be at once removed. In consequence of the great velocity of the current in the main trunk, decomposition in the sewer will be considerably checked, and the obnoxious matter will always be in motion, and conveyed at once to the outfall.

The favourable nature of the inclination of the sewer, together with other circumstances, determined Mr. Shaw in recommending that it should be made circular in shape, as the best form to resist both external and internal pressure, requiring the least quantity of material in its construction, and including within its perimeter a greater area than any other figure of equal perimeter.

In determining upon the size and capacity of the sewer, it is calculated to remove all house drainage equal to the supply of 5 cubic feet of water per head per diem, in addition to a rainfall of 1 inch per hour, added to the small quantity of spring water which may be obtained by subsoil drainage. The sewer will, in flood times, render a great service to the low flat ground in the centre of the town, by removing to a distance the surplus water from the Beck, thus preventing those disastrous effects which were witnessed some years ago, and the less serious damage to the goods and other articles which are deposited in the cellars and underground rooms of many warehouses and dwellings, which is produced by the ordinary flood waters. The total amount of covered area proposed to be drained is 2092 acres; this area provides for a large increase of population.

It is proposed to construct the sewer with radiated hollow bricks, equal in quality to those now made at Low Moor, the invert to be laid in Portland cement. The advantages to be gained by the use of hollow bricks are, increased strength, economy of materials, a saving of labour and cement, impermeability, a greater soundness in the burning, owing to the fire having access to the interior of the brick. Keys will be added to the exterior, thus giving the sewer greater power to resist internal pressure, to which it will sometimes be subject.

The inlets into the sewers will be effectually trapped by the employment of syphon traps at the heads of all house drains; and where gullies, for the purpose of conveying the surface drainage of roads and streets are proposed to be constructed, they will be in connection with a cesspit, which will prevent all improper substances from obtaining ingress into the sewers.

The sewers will be thoroughly ventilated through the aid of some of the numerous furnaces which exist in various parts of the town, or by the instrumentality of a furnace and shaft erected expressly for this object, in a manner somewhat similar to that in which the foul air is extracted from colliery workings.

The velocity of the water will be greatly accelerated if all the junctions be so made that the axes of the subsidiary sewers be portions of circles tangential to the axis of the main sewer, and the curves of the largest possible radii.

With regard to the disposal of the sewage, it is unquestionable that whatever its commercial value may be, hitherto no works on a large scale have been successful, although there are numerous places where the application of sewer water has produced very beneficial results; as, for instance at Edinburgh and Milan. Experiments are in progress at Cardiff Gaol under Mr. Higgs, and also at Leicester, under the superintendence of Mr. Wickstead. Mr. Yarrow has also a process by which he produces a very valuable manure from sewage. The great difficulty appears to be in securing in a permanent form the ammoniacal salts. The use of lime-water causes the precipitation of organic matter, but it appears that something else of a sufficiently preponderating affinity between the lime and the carbonic acid gas, to cause the latter to quit its combination with the ammonia to join the lime, is required. Mr. Stothert professes to accomplish this by the use of sulphate of alumina; and recently, an opportunity was given of witnessing his mode of operating upon the sewage derived from the Northumberland-street sewer, London, which, as an experiment, was eminently satisfactory, the water being delivered as clear as crystal. How far the result of its application on a large scale may justify his expectations it is difficult to say.

The estimate of the cost of constructing the proposed sewer amounts to the sum of 13,019*l.* 1*s.* 7*d.*; and a rate of something under one penny in the pound will suffice to pay off this sum, with interest at the rate of 5 per cent. per annum, in the course of thirty years.

E. W. Shaw, C.E.

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## ON THE WARMING AND VENTILATING OF SCHOOLS.*

By Neil Arnott, M.D., F.R.S.

[*Lecture delivered at the Educational Exhibition, July* 13*th*.]

The lecturer began by remarking that it would be difficult to overrate the importance to this and all countries which have a cold winter season, of the art of warming and ventilating, but that as yet, although scientific men judge correctly in regard to them, the mass of the people nowhere suspect the true magnitude of the evils springing from the existing defects. The public may be shocked occasionally by hearing of multitudes perishing from jail or ship fevers, or cholera, generated in confined air, and may observe the temporary illness of persons who have been in crowded and ill-ventilated churches, concert-rooms, theatres, &c., but the more permanent injury to health, the early mortality, and the diminished enjoyment of life suffered by large classes who occupy ill-ventilated dwellings, manufactories, or schoolrooms, escape common notice. A century ago men did not suspect the possibility of there ever being on earth such steam-engines as we now possess, or railways, steam-ships, gaslights, penny postage, &c., all of which are the recent fruits of human ingenuity, and chiefly of the ingenuity of men in this country; but now, when all have perceived the extraordinary benefits obtained, and the evils avoided by these novelties, they would deem the world much less worth living in if such things did not exist; so the time is probably not far distant when in public estimation the sanitary arts of which we are to speak to-day will be regarded as things of high value.

* From the 'Journal of the Society of Arts.'

The lecturer then observed that nature warms by the sun, and is always ventilating, that is to say, removing from about persons the air rendered poisonous by their breathing or otherwise, through the agency of wind, and of the warmth given to the breathed air; this warmth, by causing dilatation of that air, or greater lightness under the same bulk, produces a movement upwards, and of the foul warm-air departure, urged by the pressure of the surrounding heavier pure air taking its place.

Art imitates nature closely. It warms by fire, and it ventilates by using partly the natural agencies of the wind and the lightness of warmed breath, but also by using the strong upward movement in chimney-flues of the hot air which has fed combustion below, and is called smoke. This air, by being made to fill the chimney-flue as a light column, is pressed up by the surrounding heavier atmosphere with force proportioned to the difference of specific gravity and the height of the chimney. A heated chimney with an open fireplace is therefore constantly changing the air in the bottom of the room.

The lecturer then referred to the new arrangement of the open fireplace described in a paper read by him two months ago in the hall of the Society of Arts, and which was favourably received by the scientific men there assembled. He briefly recapitulated and explained, by diagram, the chief peculiarities of that fireplace —1, its being smokeless; 2, its saving much fuel; 3, its having much stronger ventilating force than other open fires; and 4, its taking away the foul air collected near the ceiling of the room, instead of the purer air from below. He gave his opinion that this fireplace, having the dimensions of its parts and adjuncts adjusted to the purpose in view, will be found to be the best simple means of warming and ventilating schoolrooms.

The modifications required for a school are—

1. The chimney ventilating-valve to be larger.

2. The chimney-flue also from above the valve to be larger than below.

3. The chimney-top to be surmounted by a moving cowl, or one of the fixed wind-guards of kindred nature, which, when the wind blows, produces a degree of pumping action.

4. The large quantity of fresh air required for a schoolroom to be caused to enter in a distributed manner, or at various inlets besides the principal one near the fire—as from apertures in a tube placed near the cornice or across the ceiling—or in summer by the tops of the windows opened a little on the side towards the wind, or by openings near the floor; all considerable openings on the leeward side being closed.

He remarked, with respect to larger schools, that—

1. It may be necessary in winter to warm the air which enters at a distance from the fire, by letting it touch the surface of tubes or flat vessels of metal filled with water, circulating from a boiler at the fire.

2. It may be expedient to use, "at certain times of no wind and medium temperatures," the cheap ventilating pump, with light curtain valves, which has been adopted advantageously in passenger and convict ships. This pump injects or extracts any desired quantity of air with mechanical certainty, and is worked as easily as the bellows of a church organ.

3. It may be desirable to economise fuel by using the more complex pumping-apparatus (already proved, but not yet publicly exhibited) which causes the vitiated hot air in passing away from any crowd to give up its warmth to the pure air entering.

He then spoke of some other means of ventilating which are useful for particular cases, and under certain circumstances; but which, by unskilful persons, are often deemed universally applicable, and so are often employed amiss:

1. *Open Windows.*—Often allowable in summer; in winter dangerous if more than a chink at the top be opened. A thin sheet of cold air entering the room aloft will, in descending, so mingle with the hot air of the room as not to be felt by persons below.

2. *Perforated or Opening Window Panes, or Openings in the Wall.*—The same remarks apply to these as to the window opened. Such openings produce strong cold currents where there is an open fire, and foul air does not pass out by them.

3. *The Windsail of Ships.*—A capacious tube of canvas suspended from the rigging, and leading to the spaces between the decks; the mouth, expanded by a hoop or otherwise, is kept turned to the wind. This acts powerfully in strong winds, but in calms not at all.

4. A wooden or metallic tube or shaft leading from the open

air into a room, and surmounted by a moveable cowl or hood, of which the mouth always turns to the wind by the action of the wind itself. This may be regarded as a self-adjusting windsail of inflexible material.

5. Two such tubes opening into the same room or cabin; the mouth of one of the cowls being always towards the wind to receive fresh air; the mouth of the other being turned away from the wind to let used air escape. The two together act with double force.

6. Mines are commonly ventilated by two shafts, one having a fire at the bottom to render it the ascending air-shaft; the other, without fire, lets fresh air descend. If there were no fire, the ventilating action would be, in many cases, so imperfect, that workers would not be safe below.

7. In some mines a single large shaft is made to answer the purposes of two smaller. It is divided into two channels by a partition, called a brattice, made of iron plate or other fit material, and running down from the top to the bottom. One of the channels serves as the smoke-flue. This arrangement is objectionable on several accounts.

8. In imitation of this, a single short tube of metal, divided by a brattice or partition of metal into two channels, has been fixed through the ceiling of rooms, stables, &c., to ventilate them. It is much better than an open pane in the window or a hole in the wall; and either of these is much better than no ventilation at all: but it has many faults. It has no source of heat immediately in one channel, like the mine-shaft, to make it draw strongly. The most impure air approaching the opening to pass out is always rubbing against and mingling in a degree with the new air passing in. It injects and extracts much less strongly than the twin tubes described above at No. 5. When there is little wind and little difference of temperature in the two channels, there is little or no action. With closed doors and windows in the rooms below and a strong fire, both channels become inlets of cold air. The cold air entering by it is not diffused in the room, and may prove hurtful, like that from an open window. Yet, with all these defects, it will, in certain cases, prove a useful aid, because it is a high opening to the external air, and has tranquil action. The model containing one or more burning candles, to represent men, which has been use to illustrate its action, is calculated to give to ordinary observers a very fallacious notion of its nature and power.

## TROMER LODGE, DOWN, KENT.

(*With an Engraving, Plate* XXIX.)

The accompanying engraving, Plate XXIX., is a view of Tromer Lodge, Down, Kent, the country residence of the Rev. Robert Ainslie, showing the additions and alterations which have been and are about to be made.

Down is about sixteen miles from London-bridge, and, unlike what its name would imply, occupies a commanding situation; and from the top of the tower of Tromer Lodge an extensive view of the surrounding country is obtained. The Crystal Palace at Sydenham can be clearly seen from the ground-floor windows.

The additions to the old building are, the tower, porch and bow-window over, and the wing to the right-hand of the picture; all the dressings to the windows and the parapets.

The frontage, including wing and tower, is 65 feet. The tower is 10 ft. 4 in. square, the height up to the top of open parapet is 51 feet, and to the top of vane on turret 68 feet. The buildings are built of red brick, with Portland cement dressings, except the bow-windows, which are Bath stone.

The tower has been named Cæsar's Tower, in reference to the visit which the Roman Emperor, Julius Cæsar, made to that part of Britain, when he formed a camp on the common, about two miles from Down. Mr. Ainslie has in his possession very fine portraits of the twelve Cæsars, by Otho Van Veen (the master of Rubens), which will be hung in this tower.

The works have been executed by Messrs. Hopkins and Roberts, builders, from the designs and under the superintendence of Mr. John Tarring, architect.

## METROPOLITAN GAS-WORKS.

TO THE RIGHT HON. VISCOUNT PALMERSTON, G.C.B., M.P.

My Lord—May I be permitted to lay before your Lordship the following statement of an evil seriously affecting the health of London.

During the summer of last year a committee of gentlemen, with Mr. James Simpson, the President of the Institution of Civil Engineers, as chairman, employed me as their engineer to investigate and report to them upon the scientific and commercial feasibility of a plan for making gas for the supply of London beyond the limits of the inhabited districts, and supplying it into the gasholders of the existing companies, to be distributed from thence.

The manufacture and purification of the gas are now conducted, scarcely without exception, amidst dense populations; all the poisonous and other deleterious influences arising from these processes are inhaled by those who live within their reach, and the inevitable dust and smoke attending upon the distillation of the coal prevents cleanliness in houses situated even at a considerable distance from the vicinity of the gasworks.

The sanitary advantages arising from a change of this system must be at once evident.

Another sanitary advantage, but which is not so apparent at first sight, is, that the gas, being made at one well-selected and commodious spot, with every appliance for conducting the process efficiently, could be distributed in a purer state to the consumers, and the character of the emanations from the street mains and services, at present so injurious and offensive, would be to a great extent improved.

The quantity of gas now made at most of the metropolitan works is larger than their apparatus will afford with economy to themselves and advantage to the public. The extent of ground occupied by the works is entirely covered with the machinery used for the present production and storage of the gas; and since the demand for gas is rapidly increasing, the evils resulting from confined space will be augmented in the same ratio, and instead of a greater demand, as in other processes cf manufacture, bringing with it greater facilities, enabling the commodity to be produced at less cost and in greater perfection, advantageous both to the producer and consumer, the contrary is the case; and the greater the demand for gas, with the present means at the disposal of each company for its production, the greater will be its impurity, its price, and the nuisances evolved from the factories.

Gasworks are, with very few exceptions, surrounded by property so valuable that their extension is almost impossible, in a commercial sense; for the enormously increased capital which would be required would not be compensated by the saving in the cost of producing the gas.

In the new contract entered into between the Prefects of the Seine and the six Parisian gas companies, it is expressly stipulated, that *in* 1858 *all the gasworks are to be removed out of Paris*; a practical proof of the evils resulting from the presence of such works in crowded towns, since the above stipulation has only been made after mature consideration.

The Parisian gas companies will have to remove their works at their own cost. We propose to remove the London works without calling upon the companies to contribute in any manner towards the expense of doing so.

Under these circumstances, it appeared to the above-named committee, that if so desirable a sanitary reform could be effected in such a manner that the revenues of the existing companies would not be reduced, and a sufficient return for the capital required for the new works be insured, a case would be established which would not only justify the promoters in asking the public to come forward as shareholders in the new company, but would be entitled to the support of her Majesty's government.

My investigations have proved that such an undertaking is commercially practicable. The engineering features are described on the accompanying plan.

I have ventured to lay this matter before your Lordship, and in doing so, beg respectfully to state that I shall be glad to wait upon your Lordship in order to give the results of my calculations, should it please your Lordship to require me to do so.

Samuel Clegg, Jun.,
M. Inst. C.E., F.G.S.

11, *Buckingham-street, Strand*, 17*th July*, 1854.

## INFLUENCE OF EXTERNAL AGENTS ON THE DURABILITY OF BUILDING MATERIALS.

By George R. Burnell, C.E.

*[Paper read at the Royal Institute of British Architects, June 5th.]*

When the very imperfect state of that part of meteorology which treats of the constituent parts of the atmosphere is considered, it cannot be a matter of surprise that little is known to guide us to any definite conclusions as to the causes which affect the durability of building materials, and to their modes of action even under ordinary circumstances. Experience and tradition are the only authorities upon a subject of such importance; and the rules at present adopted in the selection and employment of the various classes of building materials can hardly be considered other than empirical. In the following article it will therefore be my object merely to state what is known and acted upon, and at the same time to call attention to some phenomena which require explanation.

The influence of the atmosphere upon building materials is of a complicated nature; it is chemical, mechanical, and *medial*, under which term are included all the various modifications produced by moisture, heat, and electricity.

The chemical influence, or, in other words, the decomposition determined by chemical affinity, depends of course upon the composition of the atmosphere itself, and this is known to vary in an extraordinary manner in different localities. The normal composition of atmospheric air is considered to consist principally of oxygen and nitrogen, in the proportions of 208 of the former to 792 of the latter; but there are also numerous other gases present, such as the carbonic acid, ammoniacal, hydrochloric, nitrous, and sulphuric with sulphuretted hydrogen; the proportions of all which are affected by local causes. Even in the same locality the composition varies with the elevation above the ground, and the application of some theoretical deductions have led to such signal failures as to justify us in dwelling on the necessity for examining carefully the actual conditions of each position.

It is to Messrs. Dumas and Boussingault that we are indebted for the analysis of the atmosphere quoted above, and from the researches of numerous other philosophers, it appears that the proportions of oxygen and azote are constant. Messrs Boussingault and Levy ascertained that the quantity of carbonic acid gas varied from 3·253 to 2·989 parts of gas (in volume) in 10,000 parts of air, the former result having been obtained at Paris, the latter at Andilly, near Montmorency; but Michael Levy states that the quantity of this gas in suspension varies between 4 and 6 in 10,000, the smaller quantity being that most frequently found in the open country. Carburetted hydrogen is found most abundantly in the neighbourhood of marshes; nitrous acid gas in districts which are subject to violent storms, and it is supposed to be generated by the decomposition of azote by electrical action. M. Fresenius (Ann. de Chim. 1849, p. 208) states that he found the proportion of ammonia in the air to be in 100,000 parts in volume, 0·133 ammonia, 0·205 oxide of ammonium, and 0·379 carbonate of ammonia. But M. Boussingault's observations upon the quantities of ammonia in rain-water show that it varies notably, according to the position, from 1 to 5·45. Under all circumstances, the air of the night is richer in ammonia than that of the day,—a fact which may be accounted for by the theory of the nutrition of plants, and the precipitation of ammonia by the early morning dews.

M. Chevalier (*Journal de Pharmacie*, 1835) found that the atmosphere of London contained sulphuric acid, generated, no doubt, by the combustion of coal. The same author also observed that the atmosphere of Paris contained the acetate and the hydrosulphate of ammonia, which are to be attributed to the exhalations from the numerous cesspools of that town. M. Vogel, of Munich, has the merit of having ascertained the presence of hydrochloric acid in the atmosphere surrounding the waters of the Baltic and the Mediterranean. The action of the sea breezes upon some building materials, to which I shall have occasion hereafter to refer, appears to prove that this gas is not confined to those seas. As it is furnished by the evaporation of the ocean, it necessarily varies in quantity according to the season; and we may also suspect that other deleterious gases are from time to time suspended in the atmosphere, though their existence can hardly be demonstrated on account of their minute proportions.

The meteorological conditions of the atmosphere are subject to periodical variations, and they have distinctly-marked phases of day and night, unless extraordinary phenomena occur. Thus, in clear weather, the atmosphere attains two maxima and two minima in its electrical state; the first maximum being between seven and nine in the morning, and the second between seven and nine in the evening; the first minimum about four in the morning, and the second between five and ten in the evening; but it must be observed, that its hygrometric state frequently modifies these periods. The intensity of the sun's light, and necessarily of its actinic influence, has its maximum rather before mid-day, and two minima corresponding nearly with the periods of twilight. A maximum occurs in the temperature about two o'clock in the afternoon upon the average of the year, but there is a slight irregularity according to the seasons; a minimum occurs, generally speaking, when the sun occupies a position about 14° 47′ below the horizon, according to M. Bouvard's observations in Paris; the period of mean temperature varies in the different months. The atmosphere is driest about mid-day, and contains the greatest amount of moisture at night; the deposition of dew takes place to the greatest extent between midnight and sunrise, on account of the greater cold which then prevails. In our latitudes the disturbances of the barometric action are not marked by any regularity; but there is a tendency to increase in the morning, when the barometer generally rises; it falls about mid-day, rises again about sunset, and falls once more about midnight. It may, in fact, be considered that the meteorological fluctuations of every day are affected by the relative positions of the sun and the earth, and that they correspond more or less closely with the cardinal positions of the former at rising and setting at mid-day and midnight.

The mean temperature of London throughout the year is 50° 50′, while that of the surrounding country is 48° 50′. The thermometer very rarely rises above 96°, and the greatest cold hitherto recorded in our metropolis is 5° below zero. The mean barometric range amounts only to 2·07 inches.

One of the most important conditions of the atmosphere depends upon the rate of evaporation, and the amount of humidity in suspension; and the intensity of these agents is greatest at directly opposite seasons of the year. Evaporation is greatest in summer and least in winter; the reverse takes place with respect to humidity. Mr. Daniell estimated the mean evaporation in the neighbourhood of London at 23·974 inches per annum, ranging in the various months from about $\frac{1}{2}$-inch in January and December to $3\frac{3}{4}$ inches in June, and $3\frac{1}{4}$ inches in July. Supposing the complete saturation of the atmosphere to be represented by 100, the humidity of the months of December, January, and February will then be expressed by 92. In the intervening months the humidity diminishes with tolerable regularity to the minimum of 78 at the end of June, except in the month of May, when a trifling irregularity occurs. It thus happens that the greatest amount of moisture is suspended in the air, to be absorbed by porous materials, precisely at the season of diminished temperature and exposure to the attacks of frost; while evaporation takes place at the period when the conditions of temperature are most favourable to the production and development of the salts by the previously-absorbed moisture acting on the earthy bases.

Such we may consider the general properties of the atmosphere likely to affect the conditions of building materials, and we may trace their influence under circumstances apparently very dissimilar.

The various external agents produce effects, either by the new combinations they superinduce between the earthy bases, the metals, and the metalloids of the different classes of building materials and the gases they contain, or by the solution and removal of the combinations previously existing. There are few, indeed we may almost say that there are no conditions either of organic or inorganic chemistry which can be considered permanent; and as the gradual decay of rocks is a law of nature everywhere, and inevitably, at work to renew the face of the world by apparent destruction, it is not be expected that the insignificant quantities we deal with can be exempt from similar laws. The consideration of the circumstances attending the formation of the new compounds of oxygen, hydrogen, carbonic, ammoniacal, and hydrochloric gases with the bases above mentioned, with the action of the fermentation of woody sap, would lead to a lengthened investigation of the most abstruse branches of chemistry. The importance, however, of these compounds cannot be too strongly insisted upon, nor can the attention of scientific men be too decidedly called to them. Sometimes they act to destroy, at others to consolidate; but in all their influence is very marked, and calls for serious consideration from the architect. Limes, cements, and some descriptions of building stones, when properly employed, gain in strength and durability by the slow, but sure, action of the air. When injudiciously employed they rapidly decay, through the decomposition to which that element gives rise, or the mechanical agents to which it serves as a medium, while the destruction of the metallic or the organised matters employed is equally occasioned by the same cause. I shall now proceed to point out the various phenomena exhibited by the respective classes of building materials usually employed in London, not attempting, however, more than a very general description of a subject so vast, and at the same time so complicated.

Granites present many varieties, differing greatly in their composition and the mechanical arrangement of their elements. Those from Devonshire and Cornwall contain a large proportion of schorl, and are frequently pervaded by masses of felspar, of such dimensions and so distinctly crystallised as to cause them to assume a porphyritic character. According to Sir H. De la Beche, the granites of Ireland are of the same character, but the schorl occurs in smaller proportions. The granites of Aberdeenshire are more decidedly micaceous, and schorl is rarely found in them; they also differ from those of England and Ireland in having their component parts more equal in volume and more evenly distributed. In some cases, hornblende takes the place of mica, and in others the quartz and the felspar are so much affected in colour by the presence, doubtless, of hydrous oxide of iron, as to give a general rosy hue to the whole mass. An instance of this is the well-known granite of Peterhead. The granites of Guernsey, Jersey, and the Isles Chausey, which are occasionally brought into the London market, resemble those of Cornwall; and, indeed, M'Culloch, in his 'Classification of Rocks,' states that they pass into the same variety. Their appearance is, however, sometimes diversified by the occurrence of large, imperfectly-shaped crystals of compact felspar, which give the whole mass either a greenish tinge, as in the case of the Guernsey, or a rosy one, as in that of the Jersey granite.

The decomposition of granites takes place from the action of the atmosphere upon their constituent particles. "The quartz is almost pure silicious earth, in a crystalline form. The felspar and mica are very compounded substances, both contain silica, alumina, and oxide of iron. In the felspar there is usually lime and potassa; in the mica, lime and magnesia. When a granitic rock of this kind has been long exposed to the influence of air and water, the lime and the potassa contained in its constituent parts are acted upon by water and carbonic acid; and the oxide of iron, which is almost always in its least oxidised state, or in that of the protoxide, tends to combine with more oxygen; the consequence is, that the felspar decomposes, and likewise the mica, but the first the more rapidly." Such are the words in which Sir H. Davy ('Agricultural Chemistry,' p. 189) describes the mode of decomposition of granites; and they may be taken to express the present state of science so far as the granites usually employed in England are concerned. But there appear to be different conditions in the combinations of the bases of felspar which give rise to some apparent anomalies. Thus the Egyptian porphyries, which contain a notable excess of rose-coloured felspar, resist the influence of the atmosphere in an extraordinary manner. Possibly this may be accounted for by the closeness of the grain (so to speak) which would to a certain extent prevent atmospheric moisture from communicating with anything beyond the immediate surface; or the more simple character of some of these porphyritic rocks may be favourable to their preservation; whereas the different rates of expansion of the ingredients must have a material mechanical influence in disintegrating rocks when they exist in considerable numbers. The difference between the rapid rate of decomposition of the porphyritic granites of Spain, Brittany, and Cornwall and that of the Egyptian specimens appears to justify the inference that the cause last suggested has great influence upon their durability. The former are, in fact, composed of a greater number of ingredients than the latter, in which both mica and hornblende are wanting.

Practically it is found that the uniform character of the Aberdeen granites resists atmospheric influences in our latitude better than the more easily worked stones of Devonshire and Cornwall.

It may perhaps be as well to call attention to the fact that the modern application of the term "porphyry" is in some cases inconsistent with its derivation; the *grey* granites of Devonshire, Cornwall, and the north-west of Spain being occasionally called porphyritic, as well as the *purple* felspathic rock of Egypt. The latter is almost entirely composed of felspar, with occasional crystals of amphibole and quartz; but the colour is entirely owing to the felspar, which is of a beautiful purple, occasioned by the presence of a large proportion of the hydrous oxide of iron. Ophite (green antique porphyry) and melaphyre (black porphyry) are instances of a similar disregard for the derivation of a generic name. A description of granite, known to mineralogists by the name Syenite, was also much used by the ancient Egyptians; it is remarkable for having the mica replaced by hornblendish amphibole, and is of a rose colour. The atmosphere does not appear to have much action upon this variety, at least in Egypt, if we may judge from the state of Pompey's Pillar and Cleopatra's Needle.

Whinstones or basalts become disintegrated unequally under the effects of exposure to the atmosphere, in consequence of the variable proportions of felspar they contain, and perhaps also of the particular combinations of alumina, lime, and magnesia, which, in connection with silica, constitute their base. If any potassa be present in combination with the silica in the shape of felspar, the action is more rapid than under ordinary circumstances, the humidity of the atmosphere decomposing the felspar into two substances, one of which is soluble, and easily removed by succeeding rains. Serpentines and the diallage rocks, which are silicates of magnesia combined with hydrates of that base, yield easily to the attacks of acids when the silicates are in certain proportions and alumina is present. The most beautiful varieties of these materials employed in the arts are obtained from the environs of Genoa, and from Zœblitz in Saxony; but it is much to be feared that the atmosphere of large towns, especially when containing sulphuric acid gas from the combustion of coal, renders the employment of even the best of these decorative materials very hazardous. It appears also, that in parting with their water of crystallisation upon exposure to the air, an unequal contraction takes place in the constituent parts of the serpentine obtained in certain localities, which in consequence breaks in an irregular manner.

The next description of building materials to be considered, in following the ascensional order of the geological series, are the slate rocks. Those worked for the supply of the London market are principally situated in North Wales, Cumberland, and Westmoreland, the former being a tolerably homogeneous clay slate, the latter much more chloritic. Exposed freely to the action of the atmosphere, both varieties appear to be tolerably durable; but Westmoreland slates decay very rapidly in damp positions when the air around them is not frequently renewed. They decay, in fact, in the covered parts, probably from the decomposition of the silicate of iron, to which they owe their peculiar colour. The combination of silica and alumina in the Welsh slates appears to be more stable than that which prevails in any other material of the same nature; for their powers of resistance to atmospheric influence are greater than those of any slates employed in Western Europe or North America. As a general rule, the denser the slate the more durable it will be; and the most important condition to be observed in its use is, that water should not be allowed to percolate between the edges of the strata. Practically, it is found that the smoother the surfaces of the slates, and the closer they lie, the greater is the pitch requisite to be given to the roof; because, under such circumstances, capillary action takes effect to a greater extent than when the slates present irregular and perceptibly large intervals.

The various sandstones, millstone grits, and conglomerates, are affected by the atmosphere, either through the decomposition of the material cementing their particles together, or by the mechanical effects of moisture. These last may consist either in the removal of the cementing material, or in the destruction of the cohesion of the particles by the expansion of the water in freezing. Many of the sandstones occur in regular layers, separated by thin films of a species of clay, as in the common Yorkshire flagstones, and when these films are sufficiently thick to offer an efficient resistance to the passage of water, to retain it, in fact, under the upper shale, the expansion during frost will almost inevitably destroy the stone. If the water should change its form from other causes, such as heat, the same effect will be produced; and it is therefore found that the Yorkshire stones of a very porous, and at the same time of a very fissile character, are unable to resist the extremes either of cold or heat. The best materials of this description are those of an homogeneous nature—such as the Park Spring, the Idle, and the Darley Dale stones, in all of which the minute subdivisions disappear, and the mass may be described as consisting of an assemblage of distinct molecules of similar nature, united by mechanical juxtaposition.

The sandstones, in which the silicious molecules are united by a calcareous cement, are far more susceptible of decomposition than those united by a silicious cement, for it appears that in the former cases the chemical combination is rarely effected between the lime and the silica; as the latter is not in the state known as free silica, nor such as can easily form combinations with other materials. In the case of some of the millstone grits, however, the cementing substance, which is silicious, forms so energetic a combination with the molecules it envelopes, that both resist the action of external causes in an equal manner, and the durability of the Bramley Fall Stone may fairly be compared even to that of granite itself. These remarks may be extended to the conglomerates—in all essential respects at least—because in fact, generally speaking, they differ from the millstone grits only in the size of their elements.

The crystalline marbles vary in such a very marked manner, both in the nature and the proportions of some of their constituents, and they have been so modified by the accidental circumstances of their geological position, that it is more than usually difficult to trace the laws of their decomposition under the action of atmospheric causes. In many instances they are traversed by veins filled in with more perfectly-defined crystals of the base of the rock, or the fissures caused by these veins are filled in with extraneous matters, such as clay, and sometimes even with minerals. Again, however regular the structure of the mass may seem, there is always a tendency in the more crystalline rocks to assume a distinct cleavage, which is often different from the direction of the planes of stratification. Under such circumstances the moisture furnished by the atmosphere either furnishes the elements necessary for the decomposition of the materials introduced into the veins, or by the mechanical effects it produces in consequence of the changes of temperature disintegrates the mass. The former class of phenomena may be most distinctly observed in the Breccias, or such marbles as the Brocatello and Oriental Jasper; the white marbles very frequently exhibit the cleavage above alluded to, and are most exposed to the injuries produced by the infiltration of water between the planes of division. It is to be observed that the species of false stratification indicated by the cleavage is most apparent in the rocks which, like the slate rocks, have been affected by proximity to igneous formations, and that the more crystalline the marble the more exposed it is to this inconvenience. At the same time it must be observed that the more perfectly crystallised carbonates of lime, under which denomination, in fact, nearly all the finer marbles may be included, resist the chemical influences of the atmosphere more successfully than similar substances where the forms are not so distinctly marked. It would appear as though the process of crystallisation were accompanied by the development of some chemical affinity between the ultimate particles, similar to that which is noticed with respect to the various forms of silica, and which enables them afterwards to resist more energetically external causes of decay. In some marbles the joints assume different directions from either the lines of stratigraphical deposition or from the planes of cleavage; but in the practical operations of building the consideration of this peculiarity may be neglected, because they are usually so distinctly marked as to place in reality the natural limits to the sizes of the blocks raised.

M. Durocher communicated to the Académie des Sciences a memoir "sur l'absorption de l'eau atmospherique par les substances minérales," which throws some light on the subject of the decomposition of silicated materials, or those containing metallic oxides. From his experiments, it appears that all substances of this description actually absorb water from the atmosphere, and undergo a commencement of hydration, which must necessarily facilitate the decomposition of mixed minerals, such as the silicates, and is apparently the commencement of that action. Messrs. Jamin and Bertrand have also shown that in porous bodies gases are condensed with remarkable facility, so that it is possible that the conditions of molecular aggregation influence the durability of mineral substances in the direct proportion of the facilities which are offered to the passage of air to the interior. From this we may infer that the existence of a crystalline structure is in itself a protection to the materials in which it may occur, because under such circumstances the porosity is usually less; or at any rate the intervals between the ultimate molecules are proportionally smaller than in the case of materials held together simply by aggregation without crystallisation. Sir H. De la Beche notices the universality of this law (Geol. Observer, ed. 1851, p. 8), but he does not attempt to account for it.

The magnesian, the oolitic, and the ordinary secondary and tertiary limestones, are liable to decay under the influence of the atmosphere with very various degrees of rapidity; and it is, moreover, to be noted, that the same formations yield materials varying singularly in their powers of resistance according to the position they occupied in the quarries, and the exposure of the building in which they are employed. The results obtained by the use of the Anston magnesian limestone, and the marked differences to be observed in the Bath, Caen, and Portland oolites, as well as in the several members of the tertiary series of the Paris basin, appears to show that no *a priori* laws can be laid down with respect to their durability when exposed to the air. All these classes of materials are supposed to have been deposited by waters containing their elements in solution, and if they were once in that state (*i. e.*, of solution) it must be evident that they are always susceptible of passing into it again, if the necessary conditions are presented, unless the deposition should have been effected by the introduction of some additional element, or such element should have been supplied at a later period. There is another chemical agent at work in many cases to hasten the decomposition of the sedimentary rocks unaffected by Plutonic action—namely, the animal matter which they so often contain; and as the distribution of this matter is not subject to any definite law, it necessarily produces irregular effects. Occasionally, also, the body of the stones is traversed by numerous fissures, which have been subsequently filled in by more crystalline materials of greater powers of resistance; and again, the chemical nature of these stones often varies, owing to the presence of more or less silica in combination with the ordinary bases. Every possible variety in the mode of disintegration may therefore be observed in these stones.

Experience has shown that the magnesian limestones are not more capable of resisting the effects of our London atmosphere than the carbonates of lime formerly used, when proper care has been exercised in the selection of the latter. Mr. Rogers, indeed, remarks (Brit. Assoc., 1849) that rain-water slightly carbonated takes up the carbonate of magnesia more rapidly than it does the carbonate of lime, and that the magnesian silicates are easily soluble, even in pure water. Forchhammer also observes, that water which contains carbonate of soda acts easily upon magnesian rocks. Now, it is very probable that the rain-water falling through the atmosphere of London should be charged at any rate with carbonic acid gas, and thus become extremely prejudicial to this class of materials; and it is possible that the rain may give rise to a catalytic action between the lime and magnesia contained in this class of stones, which would facilitate their decomposition. Every stone, as may be gathered from what has been said above, is exposed to decay in the precise ratio of its porosity, but in addition to this cause of disintegration, which acts principally by allowing water to exercise its natural mechanical powers, all the ordinary building stones are exposed to the peculiar process known by the name of nitrification, which, in consequence of the formation of the crystals of nitre, combined with a base, tends to disintegration of the surface. The magnesian limestones allow the development of this process as freely as the carbonates of lime, even if they do not offer extraordinary facilities for its action. The generally received opinion is, that the azote, furnished by the decomposition of the animal matters diffused through the rocks combines with the oxygen of the atmosphere to form nitrogen, which latter gas in its turn combines with the soda, existing in small quantities in all sedimentary deposits, to form the nitrate of soda or the saltpetre of commerce. Dumas says, that azote and oxygen combine most readily under the influence of electricity, but that the energetic bases, lime and magnesia, may suffice, especially when moisture is present, to replace that intermediate agent. At any rate, this chemical operation takes place in nearly all building stones of a porous nature; and it may confirm the common opinion, that of stones, of the same description geologically, the densest are the most likely to resist the action of the atmosphere.

The phenomena of the saltpetring of building materials are very little understood; but there are certain practical rules which may serve to guide the architect in his endeavours to avoid the inconvenience arising from it. They are—First, to employ, if possible, in damp positions, either granite, the millstone grits, the conglomerates of a purely silicious character, or sandstones free from animal matter and the sulphate of iron.

Secondly. If the cost of either of these classes of materials should render their employment impracticable, the use of any of the ordinary limestones should be avoided in positions where they are exposed to warm dampness, should it be desired to execute any coloured decorations upon the immediate surface of the walls. When from local considerations it may be advisable to employ these materials in basements or other damp positions, they must be separated from the upper structure by the interposition of a layer of some impermeable material, to intercept the passage of the water, which would otherwise be absorbed by the capillarity of the upper stonework.

Thirdly. Every precaution must be taken to prevent the saturation of the ordinary limestones by sea water, and the use of sea sand in the mortar to be employed with them must be carefully avoided, because sea water furnishes the salts of soda most likely to assist in the formation of the nitrates, and sea sand is also highly impregnated with the same salts. It is equally known that the atmosphere of the sea shore holds in suspension a notable quantity of the various salts which pass off by evaporation from the surface of the sea, and it is for this reason that stones which are exposed to nitrification suffer more rapidly in such positions than in the interior of the country.

Fourthly, to isolate decorative works effectually from the walls formed of materials in any way susceptible of saltpetring. Of late years attempts have been made in Paris and some other continental towns to revive the practice of mural decorations, but the results have generally been unfavourable, in consequence of the chemical action of the atmospheric moisture transmitted through the pores of the stones. So seriously has this cause been observed to affect internal decorations, that the architect of the new Hôtel du Ministère des Affaires Etrangères, M. Lacornée, has lined the inner surfaces of the walls destined to receive either silk panels or paintings with sheet lead, and has then battened out independently of them. In the new church of St. Vincent de Paul, the painting on the dome behind the high altar has begun to fade from the effects of the transmission of the moisture of the atmosphere through the stone vaulting. This work has not been executed more than about twelve months.

It must be observed, with respect both to the carbonates of lime and the magnesian limestones, that their principal elements exist only in the state of subcarbonates while the stones remain in the rock. They absorb carbonic acid from the atmosphere, and harden by exposure to the air; but as the hardening process will augment the cost of labour, and is moreover very slow in its action, it is rarely resorted to in practice. For many reasons, however, it would be desirable to quarry the stone required for an important building twelve months before it is to be employed, because the danger to be apprehended from frost would be avoided, and the carbonisation would be more perfect. Another very useful precaution is to cover the exposed surfaces with a wash of some description, able either to close their pores or to produce a chemical action on the stones themselves. The practice of some London masons of painting the stonework as it is carried up with a thick slime of stone dust and water acts in the former manner; the washing all exposed surfaces with an alkaline silicate acts in the latter, and it would be unquestionably preferable were it not that in some positions the addition of even the small quantity of soda, requisite to hold the silica in solution, might furnish the element of the saltpetre.

Of late years attempts have been made to cast doubts upon the correctness of the generally-received opinion, that it is essential to place stones on the same bed as they occupied in the quarry. With some few stones when in place, it may be true that the position of the layers is a matter of indifference; for the roche de St. Cloud and the Villebois stone of the neighbourhood of Lyons, amongst the secondary and tertiary limestones, have been employed without reference to the planes of bed for many centuries without inconvenience. But these cases are decidedly exceptional, and even in them the powers of the stone to resist a crushing weight are less when it is applied in a direction parallel to the beds than when it is applied transversely. In almost every other case it will be found that when stones are used the wrong way of the bed—to employ a workman's phrase—they disintegrate in parallel plates. Great care requires to be exercised to ascertain the precise direction of the natural beds, because many stones present the appearance of inclined planes of deposition, which cut the beds and joints under every modification of angle. When, from the stones having been worked in the quarry, it is difficult to ascertain the precise bed, it is possible that the mason may be misled by the greater facility with which they work in one direction, and may mistake this cleavage for the real bed. The only remedy appears to be to cause the stones exposed to this danger to be marked in the quarry, but fortunately the examples of its occurrence are rare.

The principal danger of exfoliation arises from the expansion of the moisture contained in the stone under the influence of frost, and a very elegant process was invented by M. Brard, for the purpose of ascertaining the probable extent due to this cause. M. Brard in his experiments upon the resistance of stones, caused them to be boiled for half an hour in a saturated solution of the sulphate of soda. They were then withdrawn and allowed to stand in a flat vessel, at the bottom of which was a small quantity of the same solution, the first efflorescences were washed off, and the degradation of the stones during the next five or six days, under the effects of the continued efflorescence, were taken as an indication of the probable extent to which they would be affected by frost. In the first volume of Rondelet's Art de Bâtir, p. 307 (ed. 1842, Paris), M. Brard's process is described in detail; but some very curious experiments recorded in vol. 7, 1re serie des Annales des Ponts et Chaussées by M. Minard, together with an article by M. Vicat, inserted in the same volume, throw very considerable doubts upon the exact amount of dependence to be placed on its indications. M. Vicat, indeed, very properly observes, that it still remains to be proved that the expansive action of water in freezing is identical with that of crystallisation, which can only produce energetic effect at temperatures between 68° and 86° Fahr. According to this very accurate observer, stones which are exposed to a southerly aspect, on the north of the equator, are more affected by frost than those exposed to the north; and the most efficient protection to materials of this description of a porous nature is a coating of oil paint, or any other fatty pigment which prevents moisture from being driven or absorbed into the stone. M. Minard recommends that stone should be quarried in the spring, and not employed in a building until it has been exposed to the effects of one winter at least.

In many varieties of the oolites, the fossil shells are to be observed left in high relief upon the surface by the decomposition of the materials in which they were embedded, and in Bath stone the veins of calcareous spar frequently become detached. It appears that the cause is the same in both cases, and that the shells and the veins protrude in consequence of the resisting powers of the more perfectly crystallised carbonate of lime, of which they are composed, exceeding those of the amorphous mass in which they are embedded. When nodules of flint or chert occur in the numerous varieties of carbonate of lime, the stone around them is usually more durable than the general mass of the rock, doubtless because it contains a portion of the silica in combination with the lime. It is known, indeed, that the application of a soluble solution of silica will at all times add much to the durability of the purer carbonates of lime; but it is very desirable that the conditions under which such a solution should be employed should be made the subject of close and careful experiments.

There are some varieties of arenaceous limestones and sandstones with calcareous cements, and a very remarkable silicious deposit, to be met with in the upper secondary and tertiary formations, which may eventually serve to throw light upon the chemical changes produced by the atmosphere in consequence of the very decided character they assume. For instance, the sandy beds of the Kentish rag perish in consequence of the mechanical removal of the sandy cement which binds together the particles of limestone. The grès or sandstones of Fontainebleau and Windsor forest as frequently decompose, in consequence of the removal of their calcareous cement by moisture, or by the action of the air; whilst the silicious beds of the lower chalk appear likely, from Mr. Way's experiments, to furnish materials of inestimable value to plastic art, and also affording a convenient and economical supply of the soluble silica required to compensate the deficiencies in other more generally employed materials.

With respect to the gypseous formations, it appears that where they occur in sufficient abundance to be used as ordinary building materials, they absorb moisture from the atmosphere with extraordinary facility; while they decompose with such rapidity that the municipal authorities of Paris have forbidden their being used for the walls of houses. Occasionally, however, rubble plaster stone is used for enclosure walls, but it rarely lasts more than from twenty to thirty years, when exposed to the weather near Paris. The cause of this rapid decay, according to Gmelin, is to be found in the fact that the sulphates with an earthy base (gypsum being a sulphate of lime) are soluble in water. It is also to be observed that many of the gypseous deposits, especially those found near Paris, are impregnated with an extraordinary proportion of organic matter; this decomposes on exposure to the air in warm and damp positions, and gives rise to the formation of nitrous salts to such an extent, that the saltpetre used by the French powder manufacturers, during the last war, was almost entirely obtained from cellars constructed of rubble masonry, set in plaster in the style usually adopted in France. It is possible that the gases which are present in rain water, or in the atmosphere, may give rise to a species of decomposition by relative affinity, in combination with the sulphuric acid of the gypsum.

Atmospheric influence upon bricks, tiles, and other building materials obtained by the burning of plastic clays, depends very much on the chemical composition of the clays, and on the degree of burning. Thus any distinct portions of limestone present in them would be converted into quicklime in the kiln, and when the bricks were thoroughly wetted would expand in such a manner as to disintegrate the mass. If the clay used is too poor,, that is to say, if it contains an excess of sand, the bricks will not become sufficiently fused, and upon exposure to the weather their constituent parts will separate. It is to be observed that in bricks, as in stones, decomposition does not take place with the greatest rapidity where constant moisture exists, but rather where, from the influence of capillarity, variable according to the moisture furnished by the atmosphere either directly or indirectly, a series of alternations of dryness and humidity prevail. The foundation walls of buildings do not in fact suffer so much in the parts immediately upon the ground, as they do in those at a height of from one to three feet, according to the permeability of the materials employed. When bricks made of clay containing free silica are laid in mortar, and moisture can pass freely from either one or the other, it may be observed that the edges in contact become harder than the body of the bricks. No doubt this arises from the formation of a silicate of lime and alumina, the lime being furnished by the passage of the water through the bed of mortar.

Upon limes and cements the effects of the atmosphere are very marked, although at present they are considered to be of far less importance than formerly. All the materials of this class, whether the hydraulic, or the rich limes, the cements, or the plasters properly so called, have a remarkable avidity for water, and abstracting it from the surrounding atmosphere assume the form of hydrates. If these occur in the conditions requisite to enable them to pass into the carbonates, or sulphates, a species of confused crystallisation, or aggregation, takes place. But it must be evident, from what was said in the commencement of this notice, that the quantity of carbonic acid gas the atmosphere is capable of furnishing within a moderate period is exceedingly small, and the theory that limes or cements harden originally by the absorption of that gas, and the consequent conversion of the lime into carbonate of lime, must be abandoned. There can be no doubt but that the conversion of the lime into the carbonate must increase its cohesion, but the rapid setting, to use a workman's phrase, cannot be accounted for in this manner. It appears, so far as we are able to judge in the actual state of applied chemistry, that mortars harden in consequence of the formation of an insoluble silicate of lime and alumina, the silica being either furnished by the limestone itself, or by the sand, pozzolano, or other ingredient mixed with the slacked lime. When the setting has been once effected, the absorption of carbonic acid gas from the atmosphere may tend to harden a thin external film; but the very perceptible character of this film militates against the supposition that the cause producing it can act upon the interior of the mass.

Nevertheless, the numerous classes of limes, cements, and plasters, exhibit very marked differences in their manner of resisting the action of the atmosphere. The purer carbonates of lime when used for the preparation of mortar, are excessively soluble in water; and if the mortar obtained from them be much exposed to the weather, or to the action of running water, it will be rapidly removed. The argillaceous limestones, on the contrary, furnish the elements necessary to form an insoluble double salt of lime with the silica and alumina; and if the mortars made from them be protected from running water during the period required for their setting, the action of either weather or running water subsequently will rather tend to increase their powers of resistance. The practical lesson to be drawn from these facts would appear to be, that none but the limes obtained from argillaceous limestones should be employed in damp situations. With respect to the use of plaster, the observations before made upon the gypseous stones will apply here perhaps with even greater force. Indeed the marked difference between the external aspects of the applied plaster and the natural stone, would show that in the process of calcination some element we are unable to ascertain must be driven off. It may be that the burnt plaster yields more readily on account of the absence of this very element; but certain it is that plaster of Paris very rapidly decays when exposed to the influence of the atmosphere.

Temperature appears to act in a distinct manner upon limes and cements, for if they are used in summer, without the adoption of any precautions to defend them from the sun, they invariably crack; and of course, if their water of crystallisation becomes frozen in winter, the whole mass will disintegrate. The more rapidly limes or cements solidify, the more they appear to be exposed to the danger and inconvenience of cracking in warm weather, and it would appear that the most favourable condition for their resistance is when a certain degree of uniform moderate dampness prevails. It must also be observed, that sea air has a marked influence upon the durability of some limes, because the minute particles of sea-water it contains hold in solution many salts with which free lime has more affinity than with silica.

The decay of wood superinduced by atmospheric action, is affected by a different class of phenomena from those which tend to destroy stones and metals, namely, those connected with organic chemistry; although at the same time the changes produced by inorganic elements are as powerful in the one case as the other. From the day when wood is felled to the day it is used, it requires care and attention, and when it is in place precautions should still be taken to ensure its durability. Currents of air which are either renewed with too great rapidity, or are too dry, a temperature too elevated, constant moisture at high temperatures, alternations of dryness and humidity, absence of ventilation producing wet rot, the accidental transport by the atmosphere of the seeds of certain cryptogamous plants producing dry rot, and the attacks of insects, together with the fermentation of the sap of the trees, may be cited amongst the numerous sources of danger from which it is necessary to secure wood either when in store or when employed.

When wood is exposed to frequent currents of air, especially at high temperatures, the moisture it contains evaporates too rapidly, and gives rise to cracks and fissures which either destroy the resistance of the material, or open a passage for the water contained at other times in the atmosphere to penetrate to the interior of the mass. If the temperature to which wood is exposed, whilst any sap remains in it, is too elevated, the vegetable fluids ferment, the tenacity is diminished, and when the action is carried to its full extent, the wood quickly becomes affected by the dry rot. Exposure to the atmosphere in positions where rain can lodge in quantity, contact with the ground, and application in damp situations deprived of air, will render wood liable to the wet rot; and however well seasoned it may have been previously to being brought within the influence of any of these causes, it will infallibly suffer. It is therefore of the highest importance, that whether in the merchants' stores, or subsequently when placed in a building, wood should be preserved from contact with the ground, and that air should have free access to it in every direction. The germs of destruction are often communicated whilst the wood is in store from neglect of these simple precautions; if they be once implanted, the progress of decay can never be subsequently arrested. It has been supposed that keeping wood in water tends to prevent the commencement of dry rot, because in that position the sap is washed out of the pores. If this theory is correct, it must be evident that the oftener the water is changed, the greater will be the probability of its producing the desired effect, because if it be allowed to stagnate it must become saturated with the sap in course of time, and unable to take up any additional quantity which may be present. Duhamel observed, that if wood were immersed immediately after it was felled, it would be less liable to decay than if put in water at a subsequent period; he also found that immersion tended to preserve the wood from the attacks of insects, and even to arrest the progress of some kinds of decay, but that a notable portion of the strength was lost. The drying and seasoning take place with greater rapidity after immersion, probably because the water displaces the sap, which does not evaporate so rapidly as the thinner fluid. Duhamel asserts that the process of charring the ends of posts, &c., built into the ground, is very inefficient, and that it is only of use to the extent of interposing an extraneous substance between the wood and the earth; in his opinion it would be better to enclose the lower ends in sand, stone, cinders, or other materials which would easily carry off the water supplied by the surrounding media.

When wood is converted and placed in a building, its durability may be greatly increased by covering it with a coating of paint, or other substance which will prevent the moisture of the atmosphere from obtaining access to it. But it is essential that the wood so covered should be free from sap or internal moisture, or the very perfection of the coating will be found to accelerate its decay. Care must be taken to prevent water from finding its way into the joints, and if the wood be exposed directly to the action of the sun, it should be painted of a colour able to reflect rather than to absorb heat. It is desirable that it should be planed before being painted, in order that the paint may be applied in an equal manner over the surface. It is important also to observe, that the moisture in the atmosphere not only affects the volume of the wood, but frequently alters the position of the fibres by producing a torsion analagous to that which may be observed in hygrometric cords.

Of late years the processes of Kyanizing, creosoting, and immersing, timber in solutions of mineral salts, have been applied with various success for preserving it from rot, and the attacks of worms or ants. Of these, Kyanizing, which employs a solution of deutochloride of mercury, appears to be most satisfactory; and among some striking illustrations of its results may be cited the fence of the Regent's Park; the posts of which were inserted in the ground, without being painted, at least 18 years since, and remain at the present day in very tolerable condition. For railways, and harbour works, English engineers appear to prefer the system of creosoting, or immersing the timber in the rough oil of tar, until it has absorbed at least 7 or 8 lb. per cubic foot. The difficulty of injecting so large a quantity of oil is overcome by exhausting the sap and moisture from the wood in vacuo, and then forcing in the oil under great pressure; a species of artificial drying is, however, frequently necessary, and indeed the success of this process appears to depend entirely upon the extent to which the original moisture is withdrawn. Both corrosive sublimate, and oil of tar, are capable of resisting the causes of decay communicated by the atmosphere, and the latter is said to be an effectual preservative against the attacks of boring animals; but it is to be feared that the ordinary manner of applying them does not ensure their penetration to a sufficient depth to attain the objects desired. The use of the sulphate of copper, and of the other metallic salts has hitherto been unsuccessful.

In the bent timber bridges which have been constructed on some of the recent lines of railway, although every ordinary precaution was taken in selecting the timber, immersing it in solutions of the metallic salts, and in painting it when in place, the wet rot has exhibited itself in so many instances as to render it almost necessary to abandon a system which appeared to have many recommendations. It is however, to be observed that these bridges decayed solely because their elasticity caused them to yield upon the passage of every train. The play thus produced caused the joints to open; and moisture, furnished by rain or the condensation of vapour, found its way into the interior of the beams. The failure of the bent timber ribs in such situations does not, therefore, in any manner affect the propriety of using that construction on more suitable occasions. A valuable lesson is, however, to be learnt from the above fact, viz., that it is difficult, if not impossible, to protect complicated systems of carpentry from the effects of the atmosphere, when exposed to the occasional action of heavy loads able to produce a disturbance of their main parts.

In the theatre at Munich a soluble glass was applied to the woodwork and scenery for the purpose of preserving, and, as far as possible, rendering them incombustible. This glass was in fact a solution of free silica in caustic alkali; and if the wood was properly seasoned, there can be no doubt of the value of the application, especially if it was injected under pressure. Professor Way's researches into the silica beds of the lower chalk prove that a solution of this nature could be obtained easily and economically; and the advantages it offers certainly render its application desirable.

The action of the atmosphere upon metals is even more complicated than that which takes place upon stones, because the electro-chemical changes are more efficient, and the metallic bases are susceptible of combining with a greater number of gases than the earthy bases or the metalloids. In building operations the metals commonly used are iron, lead, copper, tin, zinc, with the mixed metals, brass or bronze, and to them we will confine our attention.

Iron, whether cast or wrought, becomes rusted on exposure to the air or water under certain conditions; that is to say, the outer portions of the metal are converted into a hydrous oxide, and can be detached in scales, or flakes. Many systems have been proposed to obviate the danger and many substances applied to correct the evil arising from this cause, full information concerning which is contained in Mr. Robert Mallet's papers in the Transactions of the British Association for the Advancement of Science. His experiments appear to show that gas tar applied hot is the most efficacious for iron work exposed to cold water; and that a coating of caoutchouc varnish resists the longest in hot water; but that neither of them can be considered a durable defence. Cases cited by M. Vicat are within the knowledge of every architect who has examined this class of phenomena, which prove that in some waters, as in some positions in the open air, iron work, totally unprotected, will last an indefinite period. These exceptions are, nevertheless, so rare, and the destruction of iron unprotected is generally so rapid, both in air and in water, that constant care and attention are required to guard against the destructive tendencies of those agents. If iron work be exposed to the air in positions which render the renewal of the latter difficult, and at the same time retain it in a marked degree of dryness, the iron will become covered with a coat of rust, through which the atmosphere cannot penetrate to attack the metal beneath. If the water, in which iron is immersed, contains a very small portion of some of the earthy salts, the decomposition will take place slowly. But it is necessary to observe that these remarks only apply to iron of considerable dimensions: small wires decay rapidly on exposure to either of these causes of disintegration.

Should iron, however, be exposed to confined air in damp positions, the decay attains its maximum. Carbonic acid gas contributes much to this, for, under its influence, iron passes (to use the words of Vicat) into the state of the carbonate of protoxide, which, absorbing fresh doses of oxygen, transforms itself into a hydrated peroxide. It is indeed generally considered that oxidation cannot take place to a dangerous extent unless carbonic acid be present; and it is precisely for this reason that iron, bedded in fresh masonry or concrete, resists the action of the air, because either the mortar absorbs the carbonic gas, which has a greater affinity for lime than it has for iron, or the masonry is sufficiently dense to protect the iron from contact with the atmosphere. The investigations of the Commission in 1850, respecting the fall of the bridge over the Maine, at Angers (recorded in the Annales des Ponts et Chaussées, vol. 29, 2nd series, page 394) appear to prove that the preservative action of the lime depends upon its being in immediate contact with the iron, and that if a space, however small, be left between the two substances, moisture will insinuate itself, and in course of time produce active oxidation. Vicat, in a note inserted in the Annales des Ponts et Chaussées for May and June, 1853, appears to doubt the correctness of this conclusion, but even he admits that the preservative action of the lime depends upon its absorption of carbonic acid gas, and that directly its hardening ceases, it loses its power of resisting the action of the atmosphere on the iron.

M. Payen found that the addition of very small quantities of the sub-carbonate of potassa, or of sodium, to pure water, was sufficient to render it innocuous either to cast or wrought iron, and the same property existed in nearly all alkaline solutions; whilst, on the contrary, the addition of a small quantity of the chloride of sodium rendered the process of oxidation much more rapid than it usually is in pure water. It appears that grey cast iron is more susceptible of destruction by oxidation than either wrought-iron or white cast-iron; and that wrought-iron resists the action of sea water more effectually than cast. It is a peculiar fact connected with this subject, that iron, exposed to frequent displacements, shocks, or vibrations, is less affected by oxidation than when it remains constantly in one place, without disturbance. Thus, anchors in constant use are less exposed to rust than those preserved in the magazine; the rails of the main-lines of railroads are less corroded than those in the sidings; iron steamers rust less when in active service than when in dock. But the positions in which iron decomposes with the greatest rapidity, are those where it is fixed, and alternately exposed to the air and immersed in sea water. Ammoniacal and sulphuric acid gas exercise very serious effects upon the durability of cast and wrought iron. It is important, therefore, to prevent their use, either in urinals, roofs over gas works, or the engine sheds of railway stations. There appears also to be some danger in using iron in contact with sulphate of lime, or in fact under any circumstances where it is likely to take up sulphuric acid gas, for which it has great affinity.

The galvanisation of iron, which, as generally practised, consists in forming a superficial coating upon the metal by immersing it in melted zinc, appears to constitute an efficient protection, so long as the iron is covered. The contact with the zinc brings the iron into an electro-negative state, and it is known that, so long as the latter prevails, there is little tendency on the part of the iron to combine with oxygen. From a series of experiments made at Brest between the years 1842 and 1851, (see note by M. Dehargne, Annales des Ponts et Chaussées, 1851) it appears that the zincing process does not, in any sensible degree, affect the tenacity or the ductility of the iron; but it is important to secure the protected metal from any shocks, or friction, likely to remove the surface.

Zinc, when exposed to the atmosphere in its ordinary state, becomes rapidly covered by a whitish efflorescence, which adheres to the metal, and forms, as it were, a species of varnish, capable of arresting any further decay. This efflorescence is considered to be a carbonate of zinc; but if the atmosphere should contain any sulphuric or hydrochloric acid (as in London and in the immediate neighbourhood of the sea), compounds are formed of a nature to compromise the solidity of the metal. In the purer atmosphere of Paris, and other continental towns, where wood is the ordinary fuel, and to which the sea air does not reach, zinc is employed successfully for roofing purposes; in London, and on the sea shore, its durability is very limited; and at all times its combustibility must be a serious objection to its use externally.

Copper resists the action of the atmosphere very successfully, and the presence of some of the gases mentioned above does not seem to affect it in any material degree. A film of oxide, or carbonate of copper, is rapidly formed over the surface, and secures the metal from further decay. It is found, however, that a mixed metal or bronze, made of copper and zinc, resists the influence of the atmosphere, and sea water, more successfully than pure copper alone.

Lead undergoes little change upon exposure either to air or water, especially when the latter contains small proportions of the salts of lime. According to Brande, when lead is kept in distilled water, to which air has access, small crystalline scales of oxide of lead are formed, a portion of which dissolves in the water, and is again slowly precipitated in the form of a carbonate. Soft water also, or that without the salts of lime, appears to be more likely to attack lead than that containing lime. The use of lead for cisterns must, therefore, be regulated by the nature of the water to be preserved in them; for all roofing or analagous purposes, there do not appear to exist any philosophical reasons to object to the use of this metal, or to limit its application to any particular districts.

A very important remark with respect to the use of metals must be made; viz., that when two of them are used in contact in positions where moisture, in any form, has access to them, a species of galvanic action is established, which causes them to decay with great rapidity. Illustrations of this may be observed in iron railings, when the bars are secured to the stone curb with lead, and the decay is most evident when the iron is of the best and most malleable description. A similar phenomenon may also be observed when copper, or bronze, is in contact with iron in sea water; though the iron decays rapidly, it appears to exercise a protective influence upon the copper.

The laws of electricity developed by the contact of two metals with a liquid containing a solution of an alkaline salt, are treated at some length in vol. 1, 'Gmelin's Hand-book of Chemistry,' p. 364. From this authority it appears that zinc, tin, and iron, protect copper in sea water. Zinc protects iron and tin plate, but it is not so effective for the defence of iron in sea water if air be present, and it is itself rapidly corroded when used with iron in the sea. In that element tinned iron decays unequally, the iron oxidating whilst the tin remains intact; and it appears that the decay, superinduced by the contact with tin, is greater than that resulting from the contact with copper. The corrosion of copper may be considerably retarded by fastening to it at several points pieces of cast or wrought iron, or of zinc, when sulphuretted hydrogen is likely to be present. Water containing bicarbonate of lime will deposit the lime if placed in contact with zinc and copper, the deposit taking place upon the copper; and when water of this description flows through leaden pipes, the carbonate of lime is deposited at the solder joints (composed of an alloy of tin and lead), on the brass cocks, and on any piece of iron or silver which may be introduced. The inconvenience arising from the stoppage thus produced may be obviated by the use of a lateral pipe fitted to the main at intervals, and furnished with plugs of a metal likely to deposit the calcareous matter, which can thus be withdrawn from the main.

The class of atmospheric influences included under the term medial action in the early part of this paper acts more powerfully upon some of the metals than on other building materials. Thus the tenacity of the former increases or diminishes with the temperature, and the electrical state of the atmosphere frequently modifies their powers of resistance. The most elaborate observations which have been made on this subject have been exclusively connected with the changes superinduced in iron, perhaps on account of its more general employment. They are to be found in Mr. Fairbairn's 'Treatise on the Application of Cast and Wrought Iron,' and in a communication by M. Wertheim to the Annales des Chimie et Physique (3rd series, vol. 12) from both of which it appears that the coefficient of resistance of the metal diminishes with an increase of temperature in a more rapid proportion than the dilatation. Below and near the freezing point cast-iron becomes exceedingly brittle, but between about 40° and about 120° Fahr. there does not appear to be much change in its elastic powers. The lineal dilatation of metals, and indeed of all building materials, requires to be carefully attended to in all constructions. Very useful tables upon the subject are to be found in Weale's 'Engineers' and Contractors' Pocket-book for 1854,' and in the 'Annuaire du Bureau des Longitudes.'

Glass under certain circumstances is affected by the action of the atmosphere, for the potash and soda employed in its manufacture are susceptible of being decomposed and removed by the moisture, or the gases contained in it; and according to Gmelin the decomposition takes place with greater ease in proportion as the glass is richer in the above-named alkalies, and the temperature of the moisture or water is higher. Glass in which there is a deficiency of silica is exposed to this description of decay, which may often be distinctly perceived in window glass, the alkali from which is gradually attracted (Knapp's 'Applied Chemistry,' vol. 2, p. 8) by atmospheric moisture and washed away, whilst a thin layer of silica or silicate of lime remains upon the surface and exhibits a play of prismatic colours. An analagous decomposition takes place in the glass used in stables in consequence of the ammoniacal gases; and according to Knapp, glass containing oxide of lead is liable to blacken on exposure to air impregnated with sulphuretted hydrogen.

The chemical changes produced in oleaginous and metallic pigments by the gases contained in the atmosphere are subjects of the highest importance to the decorative artist, but as the examination of them would extend this paper too far beyond the usual limits, I must refer the architect who would investigate them to the researches of M. Chevreul in the Memoires de l'Acadèmie des Sciences, 1850 (vol. 22). I may, however, state that M. Chevreul attributes the solidification of paints to the oils they contain absorbing oxygen from the atmosphere, and states that the driers act by facilitating the power of absorption. The various substances introduced to communicate colour appear to affect the rate of absorption; and the surfaces upon which the paints are applied have an influence independent of their mere capacity of taking up moisture. The varieties in the rates of drying upon the several woods and metals, experimented upon by M. Chevreul, indicate some peculiar differences in this respect, which have not hitherto been sufficiently examined.

## APPARATUS FOR MEASURING AND GOVERNING THE FLOW OF WATER AND OTHER LIQUIDS.

THOMAS TAYLOR, *Patentee*, November 15, 1852.

(*With Engravings, Plate* XXX.)

THESE improvements consist, firstly, in admitting liquids to meters through an orifice or orifices capable of expansion and contraction, so as to possess varying areas, for the purpose of rendering the action of the measuring apparatus more sensitive when a comparatively small quantity of the fluid is drawn off. Secondly, in an arrangement and construction of valve for governing the flow of fluids,—one point of novelty of which consists in forming the valve of metal, covered with gutta-percha, and fitting it to its seat by applying the gutta-percha in a plastic state; and another peculiar feature is the method by which a valve is opened and closed.

In Plate XXX., fig. 1 is a plan, with the casing in section, of a meter; fig. 2, is a vertical section of the same; and fig. 3, is a detached view of one of the orifices by which the fluid is admitted,—the parts being shown in two positions. The principle by which the measurement is effected, is the rotation of a wheel provided with vanes, against which the fluid is caused to impinge, so as to effect its revolution. It is evident that, however accurate the construction, a force of fluid, beyond a certain amount, must impinge upon the vaned wheel, before a rotation can be effected, and consequently before a measurement will be indicated. Before this necessary action, therefore, can be obtained, a certain amount of fluid may be drawn off, without producing any effect; and although this quantity may be very small in reference to the construction of meter, it is yet desirable to reduce it; this is effected by causing the orifices to contract or expand by a self-acting process, according as less or more fluid is allowed to pass from the meter. In the figures above referred to, the rotatory drum or wheel *a*, is mounted upon a shaft within a casing *b*,—the fluid to be measured passing inwards through nozzles *c*, connected with passages; and to these nozzles the improved apparatus is attached. The passage *d*, by which the fluid enters, is provided with a valve or shutter *e*, turning upon a centre at *f*; and to this centre is attached a vane *g*, extending towards the centre of the drum *a*. The axle of the valve *e*, also carries an eccentric pulley *h*, to which is connected one end of an elastic band *i*,—its other extremity, after passing over a pulley *j*, being attached to an arm *k*, which also carries the pulley *j*. By the elastic force, therefore, of this band, the valve *e*, when not forced outward, is kept to its seat within the nozzle *c*, so as to close the aperture, with the exception of a small orifice formed by a pipe *l*; which pipe extends outwards so as to deliver a stream of fluid at a point almost in contact with the vanes of the drum *a*. Suppose the parts to be in the position shown at fig. 3, and that a small quantity of fluid be drawn from the meter,—to supply the place of this, a like quantity must pass therein; this will take place through the small orifice of the pipe *l*,—the valve being kept to its seat by the elastic band *i*; and as the pressure is thus concentrated, sufficient force will be exerted to turn the drum *a*, upon its axis, and consequently register the quantity of fluid used. The drum *a*, having been thus put in motion, and a more considerable quantity being now drawn off, a circular stream of the fluid will take place, and by acting against the blade *g*, will turn the valve *e*, upon its centre, so as to open the full area of the passage *d*, as shown in dots at fig. 3; and in order to provide for this motion, a slot *m*, is formed in the nozzle *c*, through which the pipe *l*, may pass.

The second improvement is shown as applied to a "stand-pipe," in the vertical section, fig. 4. To the upper part of the pipe is adapted a box *a*, within which is placed a valve *b*, turning upon a joint at *c*: this valve is formed of metal, to which a piece of gutta-percha *d*, is affixed, and having been made plastic by heat, is moulded into the seat *e*. To the metal plate of the valve is jointed a link *f*, connected to a short lever *g*, fixed to an axle *h*, one end of which passes through the box *a*, and is there provided with a handle *i*. By turning this, therefore, the valve will be lifted from its seat, and the fluid allowed to pass through the orifice *j*,—the pressure subsequently returning it to the closed position.

*Claims.*—First,—the adaptation of apparatus capable of contracting and enlarging the induction orifice or orifices by the action of the fluid to be measured. Second,—forming a valve by moulding gutta-percha in a plastic state on to the seat thereof.

## IMPROVED WATER FILTER.

(*With Engravings, Plate* XXX.)

THE filter that forms the subject of the present paper,—the original invention of Mr. James Forster of Liverpool,—consists of a small apparatus attached to the cock from which the supply of water is drawn, the water being passed through the filter at the time of discharge.

The construction of the filter is shown in Plate XXX., in which fig. 5 is a vertical, and fig. 6 a horizontal, section of a plate; the filtering material consists of a hollow stone cylinder A A, about 4 inches diameter, 7 inches long, and ¾-inch thick, with a rounded close end below, and cemented at top into a groove in the cast-iron cap B B. This cap has a brass delivery pipe C, communicating with the interior of the stone cylinder, and bent to prevent the escape of water when not required.

D D, is a cast-iron base into which the supply pipe and cock E, is fixed; and a cylindrical tin casing F F, is fixed in a groove in the cap and base, and is secured by the frame and screw G G, connected by two side pins to the base, and screwed down upon the centre of the cap, making the joints water-tight.

When the supply cock E, is opened, the water fills the outer casing, filters through the stone cylinder, and is discharged by the delivery pipe C; the stone being a fine-grained pure sandstone, suitable for the purpose, retains all the impurities of the water upon the outer surface, and delivers the water in a pure, clear stream. The action of the filter is an imitation of a pure spring, issuing from a sandstone rock, which may be considered as a natural pressure-filter.

There is an important advantage in filtering water immediately before using it, as its freshness is then insured; but this is liable to be impaired if the water is filtered previously, and stored up until drawn off for use. With the use of such a filter, whatever may be the state of the water in the mains, from the opening of them for repairs and other causes, a supply of pure water is always obtained for use.

The practical value of a filter is greatly influenced by the facility with which it can be kept clean; and in the present filter this object has been more particularly aimed at: the process of cleaning it is very simple, and can be effected by any person in a few minutes. The filter may work for some months before requiring to be cleaned; the general plan is to clean the filter when the water is found not to flow freely from it.

The top screw G, is then loosened and the frame turned on one side, which allows the iron cap with the stone cylinder attached to be lifted out of the casing; the outer surface of the stone being scrubbed with a piece of sandstone, and well washed, removes all the deposit, and leaves it as clean and ready for use as at first. Previous to loosening the top screw, the small screw-plug H, is opened at the bottom to let the water out of the casing; and the screw I, opened to let in air.

The deposit from impurities from the water is found to take place entirely on the outer surface of the stone, and penetrates only a very slight depth into the stone, so that it can be readily and completely cleaned by scrubbing the surface with sandstone.

When the water to be filtered is very dirty, the stone cylinder is encased in a flannel bag, which prevents the larger portion of the deposit from lodging on the stone, and saves trouble in cleaning, as well as enabling the filter to continue in action longer. In cases where the water is somewhat infected, by being exposed to any decaying organic matter, some animal charcoal is placed in a bag, or a flat perforated box, in the bottom of the filter, so that the water is purified by passing through the charcoal before entering the filtering stone.

These filters are applicable for general domestic use, as the pressure required for filtering is so small, that any house having water laid on from water-works, or even a rain-water cistern at a moderate height, would have sufficient pressure for working this filter; it is working at Lambeth, with a pressure of only 9 feet, and at the Board of Health, under about 15 feet head. The small size of the filter, and its convenience of application, make it suitable for any situation.

It appears also from experiment, that in the cases where the water is soft, and has become impregnated with carbonate of lead, from contact with leaden pipes or cisterns, this is entirely separated by the stone filter—an important sanitary advantage.

## TAYLOR'S IMPROVED WATER METER.

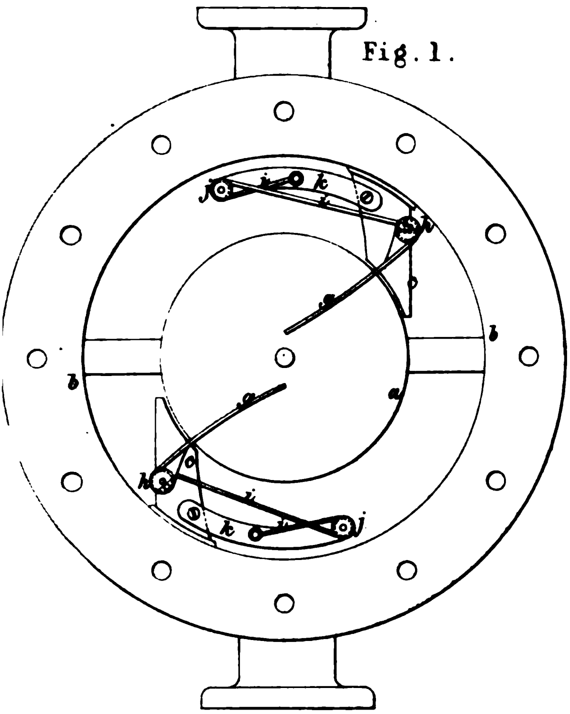


Fig. 1.

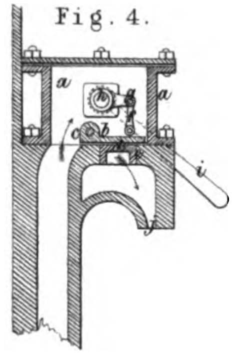


Fig. 4.

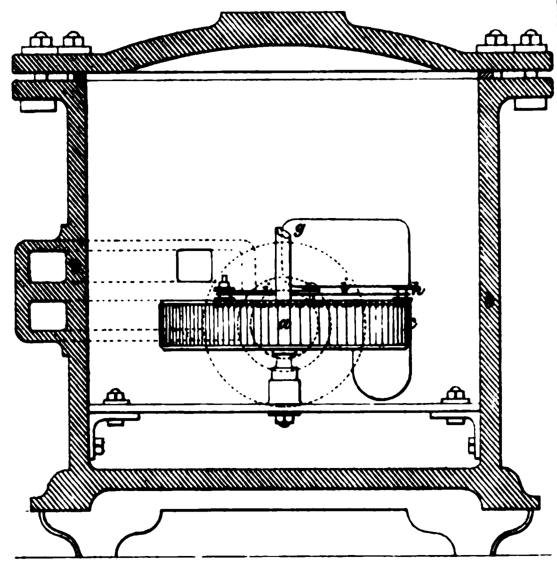


Fig. 2.

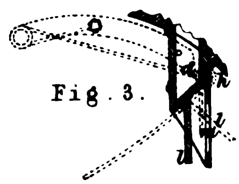


Fig. 3.

## HANSON & CHADWICK'S PATENT.

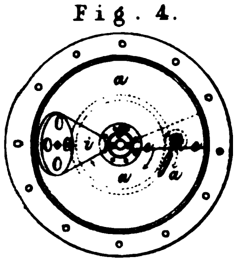


Fig. 4.

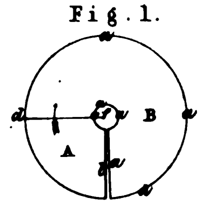


Fig. 1.

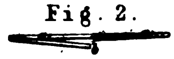


Fig. 2.

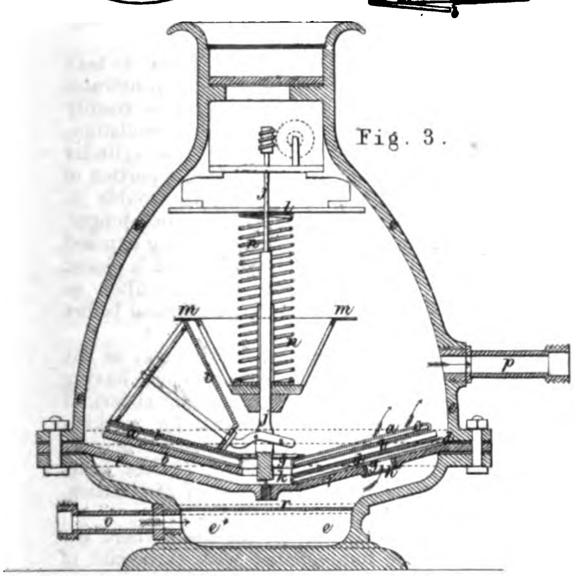


Fig. 3.

## IMPROVED WATER FILTER.

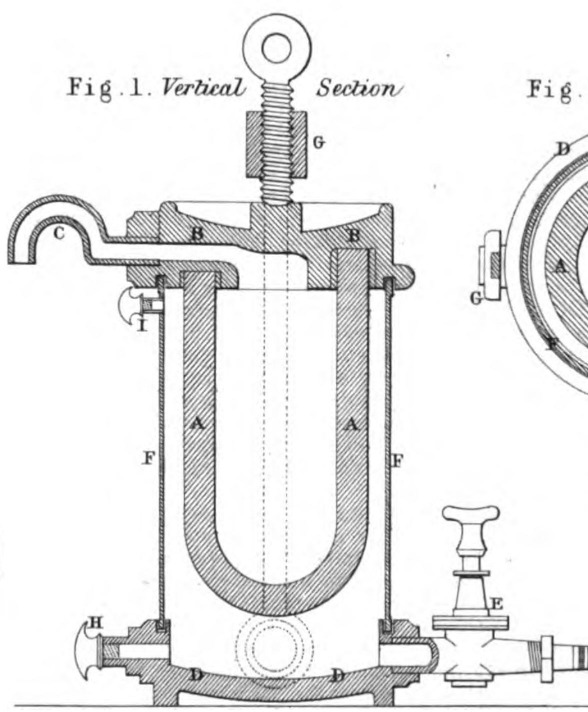


Fig. 1. *Vertical Section*

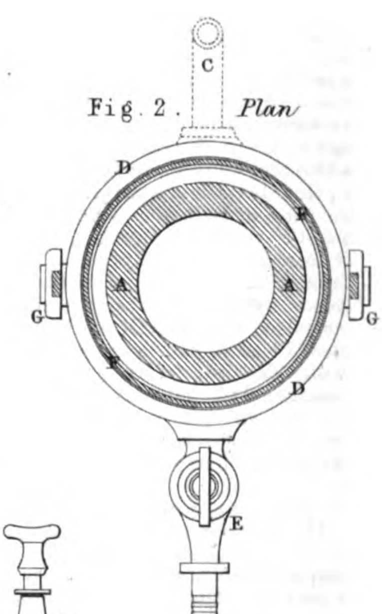


Fig. 2. *Plan*

*Scale ⅛th* 0 1 2 3 4 5 6 7 8 9 10 11 12 *Inches*

## APPARATUS FOR MEASURING GAS, WATER, AND OTHER FLUIDS.

George Hanson & David Chadwick, *Patentees*, March 31, 1853.

(*With Engravings, Plate* XXX.)

This invention consists in the use of a flexible tube or bag, into one end of which gas, water, or other fluid to be measured, enters from the main or other source, and there exerting its force against a roller or rollers placed upon the tube or bag, causes the said roller or rollers to revolve and discharge from the other end thereof the fluid which had previously entered. Each revolution, therefore, will represent a certain amount of fluid which has passed through the apparatus, and it may be registered by means of any ordinary count connected to the roller or rollers. If used for obtaining motive power, motion may be communicated in any ordinary manner.

In figs. 7 and 8 (Plate XXX.) *a*, represents a circular-flattened tube of india-rubber or other flexible material, the two ends *b*, *c*, being open; and upon this is placed a roller, so that the line *d e*, may represent that part of its periphery which rests upon the bag or tube, the said roller turning upon a centre at *f*. By such an arrangement two chambers A, B, will be formed, the one having an inlet at *b*, and the other an outlet at *c*. If a fluid be now passed through the orifice *b*, with sufficient pressure, the roller will be caused to revolve around the centre *f*, in the direction of the arrow, enlarging the chamber A, which will continue to be filled by the fluid. Upon the line *d e*, having arrived coincident with that of the aperture *c*, that orifice will be closed, and the whole tube be charged with fluid; but, the pressure being continued, the roller will be forced onward beyond the end *c*, of the tube, which will then be at liberty to open and discharge its contents, the roller passing onward to be propelled as before. One revolution has therefore represented the amount of fluid, or nearly so, necessary to fill the tube; and if such rotations, as they follow each other, be registered by any ordinary wheel-work, the quantity of fluid discharged may be ascertained.

The apparatus employed in practice as a water-meter is shown in fig. 9, a cross section of the meter, and fig. 10 a horizontal section thereof. The tube or bag, formed of india-rubber or other flexible material is shown at *a*, *a*, resting upon a metal plate *b*, which is slightly concave and cut from its outward circumbrance towards the centre; one end thus formed being bent upwards so as to constitute a spiral surface, the object of which is to bring the discharge end *c*, of the tube *a*, above that of the inlet end *d*; the former of these opens direct into a metal casing *e*, which incloses the whole apparatus. The metal plate *b*, rests upon a division-plate *f*, and its helical form is supported by occasional pieces situate between the two. The end of the tube *a*, at which the fluid enters, is closed water-tight, the passage for the fluid being formed by an orifice *g*, cut through the under fold of the bag or tube; through this orifice a metal socket passes, provided with a flange, which rests upon the interior surface of the tube, and upon which it is drawn down so as to make a tight joint by a hollow screw-nut *h*. The tube or bag is kept in its central position by a ring of metal *q*, screwed to the plate *b*. The roller which rests upon the tube is shown at *i*, provided with an axis placed within a slot formed in an upright shaft *j*. in which slot it is retained by two pins or screws, but remains at liberty to play up or down in the slot. The shaft *j*, turns on a stop *k*, at bottom, and within a cross rail *l*, at top; and upon it is mounted a circular disc *m*, the surface of which is forced upon the roller *i*, by a spiral spring *n*, the fixed abutment of which is against the cross-rail *l*. The object of this arrangement is to secure a pressure on the tube sufficient for preventing the fluid in the bag from passing under the roller. The fluid entering through the pipe *o*, passes into the lower chamber *e**, of the casing, and thence through a wire-gauze *r*, into the tube or bag *a*, through the orifice *g*, causing the roller, as before described in reference to figs. 7 and 8, to revolve, the water admitted at the previous revolution escaping by the open end *c*, into the casing *e*, from which it may be withdrawn by the pipe *p*. The revolutions of the shaft *j*, may be registered by any ordinary count; and as that part of the apparatus embraces no feature of novelty, it is not shown in the accompanying drawings.

The arrangement of the apparatus for measuring gas is the same as that of the water-meter, but of lighter construction, and formed of suitable materials for resisting the chemical action of the substance to be measured, the pressure of the gas being equalised by any known or suitable arrangement of regulating apparatus. In employing this apparatus as a motive-power engine, the only difference necessary will be to construct the machine of proper strength: motion, in this instance, may be taken from the shaft *j*, in any ordinary manner.

## THE PHŒNIX THEATRE AND BUILDINGS ON BROADWAY, NEW YORK.*

A walk up Broadway at the present time is replete with suggestion in regard to our city's growth. There is hardly a block between the Battery and Union-square that is not undergoing alterations of some kind or other. A man who should now walk it for the first time in five years would not recognise the street from anything in its former appearance which might still live in his memory. Old frame buildings have given way to marble halls, wider streets stretch out from it on every side, and the spirit of improvement is still borne onward with railroad speed. We will give a sketch of the various changes now being made along this street.

The first of importance is on the corner of Broadway and Cortlandt streets. This tract of ground, 55 by 100 feet, is being built upon by Mr. P. Gilsey. Upon it formerly stood small frame buildings, used as segar shops, card-engraving, and match and blacking stores. Mr. Gilsey, we understand, holds a lease upon this property for twenty years, at a rent of 8000 dols. per annum, for which he has refused 100,000 dols. The new building here is to be of iron, and is intended to be one of the finest ornaments in the city.

Progressing up, the next vacant space is the lot whereon stood the late store of W. T. Jennings and Co., destroyed by fire, well remembered on account of the sad calamity attending it. Upon this, we understand, is shortly to be erected a fine store.

On the corner of Warren-street is a new building just completed, built after the style of Stewart's dry goods store, and of the same material.

The next improvement is on the corner of Chambers-street, on the old site of Tiffany, Young, and Ellis. Here is to be erected an elegant structure for the Central Bank adjoining the Chemical. The size of this lot is 25 by 68 feet, and the new structure is to have a beautiful front of ornamented marble, and will cost not less than 100,000 dols. When this is completed, together with Stewart's, the Irving House, the Chemical Bank building, and the famous stores on Chambers-street, it will give to this part of the city an imposing appearance. The old building is already demolished, and the foundation of the new one is about being laid.

Now proceeding as high as Canal-street, our admiration is again taxed on behalf of the Brandreth building, standing on this corner, but not quite completed. The dimensions of these premises are 37 feet on Broadway, 128 feet on Canal, 126 feet on Lispenard, and 56 feet in the rear, giving the whole a triangular shape. It will be perceived that an architect upon such a shaped lot must work at a great disadvantage. Notwithstanding this, a splendid edifice has been erected here six stories high, having a brown stone exterior, and challenging competition with the finest of Broadway's decorations. It is owned by Dr. Brandreth, and will not cost short of 160,000 dols. It is intended for stores.

On the next block above, Mr. Dibblee is making great alterations. Two stores are being thrown into one, the building to be very neatly finished, and the premises inside to be gorgeously fitted up—in short, to be made a palace of mirrors for the hair-dressing business. Liberality in expenditure is to make this another of Broadway's richest attractions.

On the corner of Howard-street extensive improvements are being made on the former building, fitting it up for insurance companies and offices.

The next of the new buildings is the Institution for the Savings of the Merchants' Clerks, directly opposite the St. Nicholas. This bank started with rooms in the old Clinton Hall, on the corner of Beekman and Nassau, but the moving of the Mercantile Library Association compelled its directors to look for new quarters. A lot, 25 feet by 100, directly in front of the middle entrance of the St. Nicholas Hotel, was purchased, and upon it has just been completed a splendid white marble edifice, four stories high. Adjoining this, reaching to the corner of Spring-street, are five lots, which are now being cleared for the

* From the 'New York Herald.'

erection of some more giant buildings for stores. Upon these lots have heretofore stood small two-story brick houses, only a few years ago private residences, and very lately occupied as tailor shops and retail fancy stores. They are all now nearly levelled with the ground, and soon in their place, no doubt, will stand buildings worthy of association with the St. Nicholas.

Continuing our way upward, on the next block, and on the same side of the street with the the last-mentioned changes, stands, adjoining Dr. Chapin's church, a stately and highly-ornamental building, just finished for Tiffany, Young, and Co., at a cost of near 50,000 dols. This is of white marble, and five stories high. Adjoining this edifice, three lots are cleared away, the substance of the former buildings being piled along the sidewalk. Upon these, we understand, Captain French is about to erect two handsome marble stores, equal to anything that stands along this thoroughfare. The three great hotels, the Metropolitan, the Prescott, and the St. Nicholas, all within call of each other, associated with these great improvements when finished, will make this spot the great point of Broadway.

We are next intercepted in our walk on the succeeding block, at the corner of Houston-street. Here three new stores have been marked out, two of which are but just finished, and the other is now rapidly approaching completion. The first of these is a large brown stone building, six stories high, and that adjoining is of white marble, five stories high; the corner building is on a triangular piece of ground, of about half the dimensions of a lot cut diagonally. A brick building is going up here with window caps similar to those of the Prescott House. These give the premises a highly-ornamented appearance, and the three buildings, when completed, will be well worthy the association with their majestic and august neighbours.

On the corner of Bleecker-street, masons and carpenters are busily at work erecting two buildings for stores; both of these are to be of brick, and six stories high. They have already gone up two stories, and will soon be completed.

The next spot that courts our attention is the site of the late Metropolitan Hall and Lafarge Hotel, destroyed by fire last winter. But few of our citizens are aware that here is being built that which bids fair to rival all the other theatrical establishments in the metropolis. Mr. J. M. Trimble, the well-known architect, who designed and built the Broadway theatre (the Tripler Hall, as it was first called), and many others of the first buildings in the city, is now upon this spot, striving to outdo all his former triumphs. The friends of Wright, Lanier, and Co., the proprietors of the Lafarge House at the time of its destruction, failing to re-erect for them another hotel on the same spot, Mr. Lafarge, the owner of the property, resolved to raise on it a theatre and stores that should defy competition. This work was entrusted to Mr. Trimble, who is now energetically driving it on. The plan is, to build stores on the Broadway side, and the theatre on Mercer-street. One of the stores, six stories high, is now externally completed, with a white marble front. Five others are to be erected by the side of this, all of them of the same height and material. Each of these is 25 feet wide and 85 feet deep.

In the rear of these stores is building a new theatre, to be named the Phœnix Theatre, or the Metropolitan Opera House. This is the same dimensions as the old Metropolitan Hall, 100 by 150 feet, and when completed will be the largest establishment of the kind in the country. The rear of the theatre is where was the stage of the Metropolitan Hall, and the stage of the new establishment is in the place of the old entrance, reversing the former and the present building end for end. One of the important features of the new building is the many exits and entrances, by which the entire audience assembled within its walls, in case of fire, can be emptied into the streets at a moment's warning. The main entrance is from Broadway. One of the lots adjoining the Bond-street House has been reserved for this. On the Mercer-street side there are eight different doorways for egress, so that a sudden rush from the theatre would find no check till it reached the street. The parquette connects with the first tier of boxes similar to that of the Broadway Theatre when first built. The seats of the parquette have a gradual rise from the stage, and are so near the level of the stage that every action upon it can be seen by the entire audience. Above the parquette will be three tiers of boxes, each tier 15 feet above the other, and every tier to be finished and furnished in the neatest, strongest, and richest style. On each side of the stage rise two rows of private boxes, in all ten, and every one of them large, and having a full view of the stage. The lowest of these private boxes are on a level with the parquette, and at each end of the orchestra-seats, and are large enough to seat a party of thirty persons. They are intended for private parties who frequently wish to visit the theatre and sit by themselves. Here they are accommodated and have every portion of the stage before them.

This theatre, when completed, will seat comfortably 3500 people, and in case of any great attraction 4500 people can be accommodated. The height from parquette to dome is 64 feet. The stage, in keeping with the size of the house, is the largest in the country, the width of the drop curtain being 60 feet—20 feet wider than that of the Broadway Theatre.

On the second floor, or the first floor over the Broadway entrance, will be a large, sumptuous saloon for dinner parties, suppers, balls, or refreshments. These gorgeous halls will connect with the second circle of the theatre, and from almost every portion of them the stage can be seen. By this it is intended that in warm, sultry weather a party may, if they choose, sit at a table in the saloon, and, while enjoying their ice creams, at the same time witness all that takes place upon the stage. The inner wall of the theatre being on the second tier, wholly arched around the entire circle, opens the stage to view from the refreshment saloons, as we have just stated. These saloons, it is estimated, will be large enough to seat at a time about 1000 persons.

Between the inner and the outer walls of the theatre is a lobby 30 feet wide, making a grand place for a promenade between the plays and acts, or when one is tired of the performance. The orchestra box makes the entire circle of the stage in front of the parquette, and will be large enough to seat one hundred performers—about five times as large as the orchestra of any of our other theatres.

This theatre is to be painted and decorated by Guiseppe Guidicini, a well-known artist both in this country and Europe. As Mr. Trimble has spared no pains to make this building the first in the land, so Mr. Guidicini is resolved to make it surpass every other in the splendour of its decorations.

The theatre and the stores now being erected upon these premises will together cost something over 300,000 dols. It is intended to have them all finished by the 1st October next, and Mr. Trimble says the theatre will be ready to open by the 1st September next. At the present time one of the stores, as we have said, is externally completed, and the others and the theatre have been raised to the second story, and the work is going bravely on. This theatre, when completed, bids fair to be unlike other establishments of the kind that are now building or already in full blast, fit only for a picture gallery, or circus, pantomime, and rope dancing, but the Phœnix Theatre, while it will answer for all these purposes, will in addition to them be unequalled as a home for the drama, opera, or song.

This completes the list of the main improvements now going up in the Broadway. In addition to those we have enumerated, there are a few alterations in buildings taking place, but none of them calculated to have much effect in changing the appearance of this street.

## REVIEWS.

*Healthy Homes, and How to Make Them.* By WILLIAM BARDWELL, Architect.

It is a good sign of the times, that from all quarters a strenuous crusade is being waged against the crying sanitary evils of the day, whose name is legion, and whose malignant powers of spreading death and disease seem now, though somewhat tardily, to have aroused the lethargic energies of men, professional and in authority, as well as the masses of the public, who, in these matters, must ever be dependent upon those whose duty it ought to be to search out the pestilent defects of our social system, and provide the necessary remedies and means for their removal. The day would seem to have arrived when almost every nuisance has its own particular opponents determined to effect its annihilation. The vexed question of sewage and drainage is in a fair way to be solved, in spite of the contrariety of opinions respecting it, and the party warfare between the Board of Health and the Commissioners of Sewers. The suppression of intramural grave-yards may be expected after another visitation of cholera has revived the dying activity of corporations and parochial authorities. The squalid, ill-drained, ill-ventilated, and demoralising dwellings or styes of the labouring classes are fast disappearing in favour of well-built, salubrious lodging-houses and working-men's houses, erected by the Metropolitan Association and similar institutions in all parts of the country. The Smoke Act, it is to be hoped, will to a great extent prevent our lungs and buildings from being coated with a deposit of carbon. The waterwork companies are mostly endeavouring to supply a liquid less impregnated with mineral and animal impurities, by improved filtration, or by seeking purer sources of supply. Upon these and a host of minor evils, government commissions or private speculators sit almost daily; and though the axiom, "Trust not to partial care a general good," may be ordinarily the safest to follow, yet these questions may be safely left in the hands of those undertaking their solution, provided the public and the press continue their agitation until they are thoroughly and permanently disposed of.

Mr. Bardwell, despite the "crown of nobleness" which he plants upon his own head, and the self-commendation he lavishly bestows, has a fair title to be considered as by no means an idle agent in forwarding the successful accomplishment of a scheme of dwellings for labouring men, which meets most of the requirements of the case, and at the same time combines the advantages of efficiency and economy. If we still continue to build houses and cottages for the lower classes on the old plan of excluding as much air and light as possible, and carefully providing means to retain the vitiated gases and pernicious exhalations from crowded rooms and overflowing cesspools, it will not be because we are unavoidably ignorant of the necessary sanitary precautions and the laws that regulate the health of the human body (which will all be found in Mr. Bardwell's *brochure*), but because our wilful stupidity and inexcusable and mistaken mercenary calculations blind us from the real facts of the case.

Mr. Bardwell proves, without doubt, that it is as cheap almost in the first instance to erect houses, both small and great, in which the various and well-known evils of most structures of the day shall be avoided, and the poor man enabled to enjoy what are now wrongly-called "luxuries" of a comfortable dwelling, and learn to respect the abode he is compelled to select, instead of flying, as he not unwisely does, from the pestilential den the cupidity and short-sightedness of his landlord condemns him to inhabit. It is demonstrable that it would be more profitable to owners of land and builders, as well as a great benefit, even in a pecuniary sense, to the public in general, to provide clean, well-ventilated, properly-drained homes for working men; we are, therefore, not only robbing ourselves, but committing a great injustice to the lower classes by neglecting to do so. Our limited space will not allow us to do much more than glance at the mere index to contents of Mr. Bardwell's work, which professes to embrace every subject connected with social economy, whether it be the purification of the domestic atmosphere, the erection of fireproof buildings, or the destruction of the poor man's plague, a flea.

Mr. Bardwell, although he originates no novel Utopian sanitary system, or panacea for every evil that afflicts mankind, has taken the trouble to collect and practically apply the simple and common-sense remedies for them. With regard to the labours of the Society for Improving the Condition of the Labouring Classes, Mr. Bardwell says:—

"It is now become pretty well known, that to the larger buildings erected in various parts of the metropolis the superior artisans and their wives have many serious objections, greatly disliking the species of communism, and the apparent opportunity afforded to numerous parties of unkindly noticing their habits, or prying into their domestic economy. Their pride also revolts against the barrack-like appearance or character of these establishments, and they appear to consider themselves more at 'home' in the mean little dwellings of the back streets. So difficult is it to overcome long-established usages, or to engraft novelties upon national customs which have grown into necessities by the force of circumstances...... Hence it becomes a somewhat difficult matter to design the arrangement of sets of lodgings, to be let at a low rent, combining the means of cleanliness, decency, privacy, and comfort, with such an adequate amount of interest as will induce the capitalist to embark his money in the erection of these dwelllings."

In consideration of these excusable antipathies of labouring men, and the extension of the feeling that the amelioration of the condition of the working classes is the great economic question of the future, the idea of separate dwellings for every family found many supporters, amongst whom may be named His Royal Highness Prince Albert, and an association of gentlemen calling themselves the "Labourer's Friend Society." These last, some years ago, erected at Shooter's-hill a number of cottages from designs by Mr. Bardwell, in which the following principles were strictly adhered to:—

"That every dwellinghouse, on the floor containing its living-rooms, should be raised at least 18 inches above the general surface of the ground; that the chimneys should be placed in the interior walls; that a porch is indispensable; that the exterior walls should be hollow, so that the rooms might be cool in summer and warm in winter; that the roof should project, so as to throw off the rain-water from the walls; that there should be no valleys in the roof, to bring on decay; that the practicability of the economical application of fuel,—of the collecting, filtering, and preserving the water which falls on the roofs,—and of the collecting and economising the liquid and other manure produced in and about the dwelling,—should all be kept in view; that the smallest possible quantity of materials should be introduced, consistent with the durability and the accommodation required; and, as a consequence, that improved dwellings might be erected at a remunerative cost."

These cottages were erected at a cost of 115*l.* per pair; the outhouses 10*l.* per house; and the land (an acre and a quarter per house) 50*l.* an acre; and have paid an excellent per-centage on the first outlay.

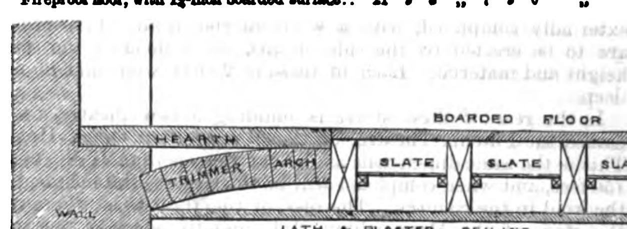
The French government has wisely employed legislative interference in the erection of "healthy homes" for workmen, and a sum of 10,000,000 francs has been devoted to their erection; of which 3,892,082 francs have been granted in subventions to contractors, for which accommodation has been provided for 5300 unmarried people and 800 married workmen in Paris, for 150 unmarried men at Marseilles, and for 300 couples at Mulhouse.

Mr. Bardwell illustrates the beneficial effects resulting from the application of the Lodging Houses Act in Wolverhampton, and the efficacy of sanitary provisions in preventing the recurrence of epidemic diseases, as exhibited in the recent improvements in Lambeth-square, in conformity with the measures set forth in the Health of Towns Act. He further advocates the somewhat impracticable idea of converting the house-tops of London into "cultivated gardens," filling the air with perfumes, and wafting health in every breeze. This he would do by making all roofs flat and fireproof, as exemplified in the flat roofs placed upon Buckingham Palace by George IV., and the plans of Mr. Frost and others; but this hygienic improvement was negatived by what Mr. Bardwell calls the "twaddle about mediæval architecture," which, he says, has caused us to retrograde to the "principles and practices of the dark ages."

With regard to fireproof floors, Mr. Bardwell estimates the difference in cost between an ordinary timber and plank flooring and one rendered fireproof by the adoption of Messrs. Fox and Barrett's (or similar) plans, to be nearly as under:—

Room, 18 feet long, 16 feet wide:—

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Timber floor, of the *commonest* description.... | £15 | 5 | 7 | or £5 | 6 | 0 | per square |
| Timber floor, of a superior description ...... | 20 | 9 | 1 | ,, 7 | 2 | 0 | ,, |
| Fireproof floor, with cement surface ........ | 17 | 3 | 0 | ,, 5 | 19 | 0 | ,, |
| Fireproof floor, with 1-inch boarded surface.. | 20 | 9 | 3 | ,, 7 | 2 | 0 | ,, |
| Fireproof floor, with 1½-inch boarded surface.. | 21 | 9 | 5 | ,, 7 | 9 | 0 | ,, |




The variations in length of cast-iron girders from alterations in the temperatures of rooms is so infinitesimally small that they need not be considered in practice. Where, however, the use of iron girders is impracticable, Mr. Bardwell has shown in the annexed engraving a method to be substituted for Hartley's patented plan of interposing sheet-iron or copper or tin between the flooring-boards and the joists. Mr. Bardwell proposes to place slates resting upon fillets between the timber flooring joists, laying them with putty or Johns' liquid cement, thus forming a close joint, and preventing all upward currents of air. When the fillets and slates are placed immediately beneath the boarded floor, and jointed in the same manner, a perfectly fireproof flooring is formed on the same principle as Hartley's fire-plates.

Mr. Bardwell shows a method of forming a fireproof quarter partition by fixing slates to the quarters by screws, one screw taking one corner of four slates. They may then be covered with paper in the usual way, or ornamental styles may be run in cement, or metal, or leather; and for splendid rooms the slates may be enamelled in the Japanese manner.

This work contains woodcuts, but no description, of a domestic fire-grate, invented by Mr. Quarm, clerk of the works to the Houses of Parliament, which Mr. Bardwell pronounces to be "simple, effective, scientific, and beautiful," and by which "nine-tenths of the smoke is consumed, and a saving of 50 per cent. in the cost of fuel is effected." This is no unimportant matter; but without having seen this stove in actual work, we should doubt, from its construction, the realisation of the grand results Mr. Bardwell anticipates. The grate is formed without any passage for the escape of smoke, except at the back, which opening rises no higher than the level of the top of the coals, so that it appears to us to be very liable to be choked up at the top by fresh fuel, in which event there is no exit for the smoke, excepting into the room. However, should our doubts not be correct, Mr. Bardwell, with rather unnecessary confidence in the stove, remarks, that "our legislators may therefore, at the expiration of one or two years, with the strictest justice, cause every householder in the metropolis to be fined from whose chimney opaque smoke is seen to issue. We wish we could concur in these observations; the abolition of the smoke nuisance from private dwellings would be a great benefit, but the means of so doing are still wanting.

There will be found appended to this work a specification and drawings entailed in the erection of a pair of "third-rate" dwellinghouses, estimated to cost 1000*l*., which, if generally followed, Mr. Bardwell (for a reason we cannot discover) imagines would entitle such masses of buildings to be called "gardens" in lieu of streets or lanes. But we must leave our readers to judge of the merits or demerits of this specification for themselves, and close our remarks by observing, that many useful, though not altogether new, means of ameliorating the numerous sanitary evils will be found scattered up and down through this somewhat rambling book.

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*Electro-Magnetic Telegraph, with an Historical Account of its Rise, Progress, and Present Condition, &c.* By LAURENCE TURNBULL, M.D. Philadelphia. 1853.

The modes of facilitating the means of communicating between different places have, during the last century, engrossed the earnest attention of the most eminent scientific men of all countries;—the extension of commerce, the requirements of science, and the increased rapidity of locomotion, imperatively demanded more ready conveyance of intelligence. The old and defective system of telegraphing by semaphores had long proved totally inadequate to the growing necessities of the last more active generations. At an early period the more diffused and intimate knowledge of the phenomena and laws of electricity suggested its employment in the transmission of communications. Its rapidity of transit, its power of decomposing chemical combinations and of deflecting electronometers, offered facilities for signalising that were not neglected by electricians, whose laborious researches and carefully-conducted experiments have at last elaborated that triumphant achievement of genius, the Electro-Magnetic Telegraph, which stretches in numberless ramifications, like a vast nervous system, over the greater portion of the civilised globe. By slow and and almost imperceptible steps has this discovery advanced; since the commencement of the 18th century philosophers have occupied themselves with the fascinating idea of rendering the electric current subservient as a means of inter-communication.

Dr. Turnbull, in his valuable work, has carefully traced the earliest indications of this extraordinary invention, and followed its progress to its present perfection, and we recommend it to the attention of all interested in the science of electro-magnetic telegraphing, as well as to the general reader. It contains very clear descriptions, illustrated with plates and engravings of every variety of electro-magnetic telegraph, together with abstracts of most of the patents relating to this subject, arranged in chronological order.

As early as the year 1729, the instantaneous transit of electricity through great lengths of wire was observed, and in 1746 numerous experiments were made in Leipsic and Paris by Winckler and N. Lemonnier, on the transmission of electricity through wire, earth, &c.; in one case more than two miles in length of wire were employed. These experiments were repeated by Dr. Watson and others in 1747, when shocks were transmitted across the Thames, and through two miles of wire and two miles of earth at Shooter's Hill; and also in 1748, by Franklin, across the Schuylkill, at Philadelphia; and in 1749, by De Luc, across the Lake of Geneva.

The nature and capabilities of the telegraphs in which electricity has been employed have naturally been varied and improved according to the progress of electric discovery. During the period from 1745 to 1800, the electric telegraph in which simple frictional electricity was employed, was alone used; from 1800 to 1825, the galvanic, where voltaic electricity was employed; and from 1825 to the present time, the electro-magnetic, combining the agencies of electricity and magnetism.

The first electric telegraph appears to have been that of Lesage, established at Geneva in 1774, consisting of twenty-four metallic wires, each in communication with an electrometer formed of a ball of elder suspended by a wire, the repulsions of which, when acted upon by a current of electricity, indicated a certain letter of the alphabet. A. Young, in his 'Travels in France,' in 1757, describes a similar contrivance, the invention of Lomond. Reusser, of Geneva, in a letter to *Voigt's Magazine* for 1794, described an electric telegraph, in which sparks, emanating from strips of tinfoil fastened on a glass, indicated preconcerted signals. Professor Boeckman proposed as signals the combination of sparks, at intervals, transmitted through but two wires.

In 1796, Prince de la Paix presented to the King and Court at Madrid an electric telegraph, the invention of M. D. F. Salva, and two years after the Infanta Don Antonio constructed a more complete telegraph under the instructions of Salva, upon the principle of which Humboldt asserts that a telegraph of twenty-six miles in length was established between Madrid and Aranjuez; other writers affirm that M. Betancourt connected these places, in 1787, by a telegraph worked by frictional electricity. In 1816, F. Ronalds constructed a telegraph of eight miles in length, employing frictional electricity. The apparatus consisted of a paper disc at each terminus, caused to rotate by a clock, and on which were marked words and signs. The discs were covered by perforated plates, disclosing but one letter at a time, consequently the transmission of a current of electricity at the required moment would indicate at both places the signal conveyed by the word or number apparent at that time. H. G. Dyer, an American, in 1827, constructed a telegraph on Long Island, and supported his wires in glass insulators on poles and trees. The difference of time between sparks acting on litmus paper and producing a red mark, indicated different letters and signs. The current of electricty was returned through the ground.

The profound researches of Volta, of Parma, on the development of electricity on surfaces in contact, of different metals when subjected to the action of acids or other aqueous solutions, or decomposed substances, between their plates, led inevitably to the abandonment of all preceding abortive attempts at electric telegraphing. Frictional electricity was too easily dissipated, and devoid of the continuous action of galvanic electricity, to be of essential service; the chemical force generated in the galvanic battery being pre-eminently more manageable, of greater constancy, and of less tendency to escape, than that produced by mechanical means.

Dr. Turnbull gives an epitome of the various batteries employed in generating galvanic electricity, describing minutely those of Daniell, Grove, and Bunsen, accompanied by the results of Faraday's experimental researches.

The first application of galvanism to telegraphing was by Sömmering, of Munich, in 1809. He employed a number of glass test-tubes, reversed in a reservoir of water, and connected by wires from a battery situated at the transmitting station. Each glass tube was marked with one of the twenty-five letters of the German alphabet and ten numerals. By the action of the battery the water was decomposed in the requisite tube, the evolution of the gaseous constituents of the water in which indicated the signal to be conveyed. The next in order of those depending on the galvanic principle solely, was the physiological telegraph of Voezleman De Haer, in 1839, which was not calculated to succeed, being based on the property of galvanism to produce physiological effects on the nerves and muscles, which sensations are found to become extinct in the operator after a short time, as is proved in the gutta-percha manufactory of Fonropert and Pruckner at Berlin, where the workmen engaged in proving insulated tubes lose sensibility in their hands and fore-arms after a day's work.

In this telegraph the signals were recorded upon a piece of calico saturated with a solution of ferro-cyanate of potass, to which had been added a few drops of nitric acid, and caused to move over rollers. The action of the voltaic current (transmitted through an indicator touching the calico), when rapidly formed and broken, produced a blue mark by the electric fluid decomposing the ferro-cyanate of potass, and forming cyanate of iron.

"The species of battery which is best adapted for producing the electro-chemical indications, consists of forty repetitions of charcoal and zinc plates; the charcoal plates being composed of three parts of pulverised charcoal, two of pulverised coke, and one of wheaten flour, mixed together with water; when formed, the plates are dried and placed in an earthen crucible, in the lid of which is an aperture for the escape of gases; in this they are heated to redness. This battery will keep up an uniform and energetic current for a considerable time, the cells being merely filled with water; the only attention which it requires subsequently being to wash off any oxide which may be deposited on the plates, and supply fresh water. The battery employed for the electro-magnetic telegraph is a calorimeter or single circle. The electricity generated by this battery has a tendency to weaken in its progress, so that the defect must necessarily be provided for by batteries at different distances, according to the desired amount of power; this objection is completely removed in the voltaic apparatus. Experiment has proved that the electric energy from the intensity battery, in producing the electro-chemical effects, increases instead of diminishes in regard to distance. Faraday ascertained that the quantity of electricity required to decompose a single drop of water is equal to that of a powerful flash of lightning, while from the largest single circuit ever constructed, not the slightest chemical effect can be exhibited. On the other hand, a small single circle, composed only of a few square inches of copper and zinc, will temporarily magnetise a large bar of iron, while a powerful voltaic trough will not magnetise a lady's sewing-needle. Throughout the whole of the practical details of the electro-magnetic apparatus a far greater amount of carefulness of workmanship is required than in those of the voltaic one. Thus the whole of the joinings of the conducting-wires require to be in perfect metallic contact and carefully isolated, whilst the electro-chemical communications may be transmitted through the medium of a wire fence," as was proved in an experiment in which the communicator and indicator were attached to the contrary extremities of an iron fence 1868 yards in length, when a number of signals were transmitted with great facility.

The next in chronological series was the instrument of Alexander Bain, depending for its efficiency on electro-chemical action, and consisting of a transmitting apparatus at one end of the line, and a recipient one at the other terminus. In the specification of his patent, 1846, Mr. Bain remarked that he had "rejected magnetism altogether, and caused the pulsations of the electric current to be transmitted through groups of perforations, forming signs, which are recorded at the receiving-station by pulsations of the electric current acting on chemically-prepared paper; so that the circuit is completed and interrupted without the electric current having to produce any mechanical motion, and without any manipulation of the operator in forming the intermittent pulsation of the electric current, thereby effecting the transmission of a communication to one or a plurality of distant receiving-stations with far greater rapidity than by any other mode."

Dr. Turnbull remarks that "this may be true in theory, but it will require more time than the simple passage of the current in practice; for in every case decomposition of the fluid will take place, and time is required for the operator to see the mark. If the paper should become dry, as it is known to do, the mark then becomes very indistinct, from the want of proper conducting material; and as the wire is not of platinum, by becoming oxidised it prevents the proper metallic contact, so that it will require an intense and constant current, which cannot be produced and kept up in the form of battery described by Mr. Bain—viz., zinc and copper battery. There is also the inconvenience arising from the fumes from the chemicals employed in preparing the paper."

In 1849, Mr. S. F. B. Morse patented in America an electro-chemical telegraph, but which was never practically used. The peculiar novelties of this telegraph were, the employment of a single circuit of conductors for marking telegraphic signs, by means of the decomposing, colouring, or bleaching effects of electricity acting upon any known salts that leave a mark upon paper, cloth, or metals; and also a combination of machinery, by which any two metallic points, as platina discs, or other known conducting substances, having the chemically-prepared material in contact with and between them, may be employed for marking telegraphic characters.

Messrs. Bain and Smith obtained a patent in 1849, having for its object the better construction and arrangement of marking instruments, keys, wires, and batteries of electro-chemical telegraphs, whereby copies of messages transmitted from any one station can be marked upon chemically-prepared paper or other fabric at one or any desired number of stations in communication therewith, and also, if required, at the transmitting station, without requiring the use of any secondary current.

Bain's system, as is well known, consists in punching the letters of an alphabet, composed of dots and lines, upon a narrow strip of paper, which is wound upon a roller, over which are four springs communicating with the conducting-wire of the telegraph line. When the springs rest on the covered parts of the paper, the circuit is not formed, but as soon as an empty space is presented to them, they touch the metallic roller on which the paper is wound, and which is in connection with the battery, and thereby complete the electric circuit. The current is then transmitted to any one or all of the stations on the line, and there recorded upon similar strips of paper chemically prepared by being dipped first into a solution of sulphuric acid, and then into a solution of prussiate of potash, by means of a small style attached to the conducting-wire of the line. The electric current is completed afterwards through the earth. In forty-five seconds the 1200 letters, composing a page or entire strip, are neatly drawn on the chemical paper.

Bain's telegraph is in operation on the North-Western from London to Manchester, and from thence to Liverpool, an extent of 186½ miles, and in America on a line of 1242½ miles.

The last electro-chemical telegraph we can notice is that of Messrs. Westbrook and Rogers, of America, the peculiarity of which is the employment of metallic surfaces to receive the signals and messages, instead of chemical paper. The metallic recording surface, after being filled and transferred, is cleaned by a sponge saturated with acidulated water.

As most of these electro-chemical telegraphs have proved hitherto unsuccessful, and, with the exception of Bain's, have not been extensively used, we will at once pass on to the consideration of the electro-magnetic system, which is now, generally-speaking, in universal operation. The present forms of this telegraph depend on the power of the electric current to deflect a magnetic needle or impart temporary magnetism to iron, or to produce electric currents by magnetic induction. Professor Œrsted, of Copenhagen, was the first to deduce any important results from experiments on the magnetising properties of electricity. He ascertained, in 1819, that when a wire-conducting electricity is placed parallel to a magnetic needle properly suspended, the needle will deviate from its natural position. And further, that this deviation follows a regular law, which he stated in four general rules—1, if the needle is above the conducting wire, and the electricity passes from right to left, the north pole of the needle will be moved from the operator; 2, if the needle is below the wire and the electricity passes as before, the north pole of the needle will be turned towards the observer; 3, if the needle is put in the same horizontal plane with the wire, and is between the observer and the wire, the north pole will be elevated; 4, if the needle is in like manner placed on the opposite side, the north pole will be depressed. To exhibit these effects, the needle must be very near to the wire. Other important facts were discovered by Ampère and Arago in France, Davy and Faraday in England; and Professor Henry and others in America. Ampère's hypothesis, which referred all observed phenomena to the laws which govern the mutual actions of electrical currents, was, that magnetism consists in electrical currents, revolving around the minute particles of a magnet, in planes perpendicular to its axis.

"The laws of electro-dynamical attraction and repulsion, experimentally established by Ampère, which serve to explain all known phenomena, are contained in the following propositions: —1, Parallel currents flowing in the same direction attract each other, and mutually repel, when their directions are opposite; 2, Two currents attract each other when they both flow towards or from a certain point, if they are not in the same plane, and repel each other when one current approaches and the other recedes from that point; 3, The attractive forces vary in their intensity in the inverse ratio of the square of the distance, their force diminishing as the distance increases; 4, The attraction or repulsion exerted by a current passing through a tortuous or helical conductor is exactly equal to that which is produced by the same current when it follows in a straight line from the same points." The magnetic needle not only acts as a galvanoscope by which the existence and direction of an electric current can be detected, but will serve as a galvanometer, and, from the degree of deflection, will indicate the exact measure of its force. It is from these qualities that the needle forms the basis of all present magnetic telegraphs.

Dr. Turnbull's work contains some interesting particulars of the discoveries and experiments of Arago, Sturgeon, Henry, Faraday, and others, in connection with the subject of electro-magnetism, but we must confine ourselves to the history of the telegraph, and at once continue the series of improvements in the apparatus and methods employed in transmitting signs and messages by means of electricity.

After Œrsted's discovery that feeble electric currents would produce a variety of magnetic actions, a fresh impulse was given to electric telegraphing, and modifications and contrivances were speedily introduced to render available these newly-disclosed electro-magnetic properties. Ampère, in 1820, was the first to devise a telegraph in which the deflection of the magnetic needle was employed. His plan consisted of as many needles as letters of the alphabet, which were actuated by electric currents passed through metallic conductors, communicating respectively with the battery by means of keys, depressed at pleasure. In 1825, P. Barlow, F.R.S., suggested an instantaneous telegraph by means of conducting wires and compasses. In 1828, St. Amand proposed to connect Paris and Brussels by a metallic wire coated with silk, and inclosed in glass tubes hermetically sealed. A galvanic battery imparted electricity to this conducting wire, which at the opposite end was to be in connection with an electroscope sensible to the slightest influence, the signals conveyed by the deflections of which were to be determined at pleasure. In 1832 and 1833, Baron Schilling, a Russian Counsellor of State, devised a needle telegraph, consisting of a number of platinum wires insulated and united in a cord of silk, which actuated by keys thirty-six magnetic needles, each placed vertically over the centre of a multiplier.

An improved form of Schilling's instrument was exhibited by Dr. Munke in 1835, in which light discs of cardboard, attached to magnetic needles inclosed in galvanic coils, were moved by the magneto-electric current. Five similar magnets, arranged so that the round discs of cardboard were presented to view edgewise, were connected by wires with the distant battery; according to the direction in which the current was sent, the magnets were deflected to the right or left, showing to the observer in the one case one side, and in the other the reverse side of the cardboard discs, thus indicating, according to an established code, different telegraphic signals.

Between the years 1833-35, Counsellor Gauss and Professor Weber, two of the most illustrious philosophers of Germany, established telegraphic communication between the Astronomical and Magnetic Observatories of Gottingen, consisting of a double line of wires carried over the house-tops. It was erected principally to investigate the laws of the force of galvanic currents under different circumstances. The greatest length of circuit was 15,000 feet, part of which was reeled. They first employed galvanic electricity by using small-sized plates, and found that the action was much increased by adding to their number. The main apparatus was a magneto-electric machine, to which Gauss adapted a commutator, by which the direction of the current could be reversed by a single pressure of the finger, with which the two ends (called inductors) of the reel were in connection, and also the two conducting wires of the telegraph. When the inductors were suddenly drawn off the magnet-bars on which they rested, and immediately replaced, two induction currents of short duration were produced, one directly after the other, in opposite directions, which were transmitted through the conducting wires. The observing apparatus at the opposite station consisted of a strong multiplicator, or square copper frame, round which an insulated wire was coiled, having its two ends in connection with the conducting wires from the other station, thus forming together a single closed wire circuit.

In the coils of the mutiplicator, a magnetic bar of about four pounds weight was suspended by 200 parallel silk threads, easily moveable in the strip carrying the bar, which could be raised or lowered by a wooden screw, to which the upper ends of the threads were attached. On a brass rod passing through the copper frame was fixed a vertical mirror, which turned with the magnet, and was so directed towards a cypher-scale fastened at the foot of a spy-glass, that the reflection of the scale could be seen through the glass. In a state of rest the null point of the scale was visible through the glass, but as by the slightest movement of the magnet the mirror was also moved, a different portion of the scale was presented to view. In this manner the signs indicated upon the cypher-scale were made to convey certain conventional letters and words.

In the year 1836, Messrs Taquin and Ettieyhausen experimented with a line over two streets in Vienna, the wires passing through the air and under the ground of the Botanical Garden.

In 1835, Mr. J. B. Morse constructed an electro-magnetic telegraph, upon which have been founded most subsequent instruments of the like character. In 1836, Mr. Morse was joined by Mr. L. D. Gale, who suggested many useful improvements. The apparatus consisted of a train of clock-wheels giving motion to a strip of paper passed round two cylinders. A wooden triangular pendulum was suspended over the paper, and vibrated at right angles to the length of the paper. At the lower end of the pendulum was fixed a pencil, kept in contact with the strip by a weight. An electro-magnet was supported above the paper, and attracted an armature attached to the pendulum; one of the conductors of the magnet helix passed to a single-plate galvanic battery, and the other to a cup of mercury attached to a port rule; the other pole of the battery was connected to a second cup of mercury. A rule or composing-stick carrying the type, the tops of which projected above the sides of the rule, was supported and moveable upon rollers attached to the port rule, at one end of which was suspended a lever, having at one end a key or tooth, which was acted upon by the type in the rule, and at the other a forked wire, which, when the opposite end of the lever was raised by the type, connected the two cups of mercury, and consequently completed the circuit, which had the effect of causing the pendulum to make one vibration for every single type, thereby causing the pendulum pencil to make a V-shaped mark upon the paper; a combination of these marks and spaces represented certain numerals, which again were typical of certain letters or words. In 1837, Mr. Morse, finding that this instrument was useless for great distances, adopted a receiving-magnet and a relay or repeating circuit. This telegraph, having been modified and improved, was tried on the line between Baltimore and Washington, in America. In the instruments thereon employed a signal lever-key was substituted for the port rule, and a lever in the register in place of the pendulum; and it was further provided with a "local circuit" and register, a receiving-magnet and adjuster, self-regulating break, and metal points were employed in place of the lead pencil to indent the signals instead of marking them on the paper.

The chief improvements on the Morse telegraph, now in almost general use in the United States, are the spring lever-key, by means of which the local circuit may be closed to allow communications to be sent through the office to stations on either side of it; keeping the main circuit continuous, it also acts as the transmitting apparatus. On merely depressing the long end of the lever, a point is made at the receiving-station, whilst, if retained down, a line is marked of a length proportionate to the time of such retention. The receiving-magnet, which is an intensity one, surrounded by a helix of fine wire 3000 feet in length, is of the horse-shoe form, and fixed in a horizontal position. The main circuit passes through this helix unbroken, by the action of a self-acting apparatus, consisting of an armature fixed to a vertical moveable standard opposite the poles of the magnet, in such manner that when the current flows through the main circuit the receiving magnet attracts the armature and closes the local circuit.

The self-acting winding apparatus, attached to the register, secures an uniformity of motion through any number of messages. It consists of an extra magnet placed in the register, causing a lever to vibrate; this lever has a click at its end, which causes a ratchet-wheel to revolve and transmit its motion to the shaft of the spring which actuates the registering apparatus. An arrangement is also made by which two points come into contact and cut off the current from the winding magnet, and consequently prevent the further winding up of the spring when powerful enough to give motion to the register, the revolutions of which, in its turn, cause the points to separate, when the current again flows through the magnet, and the winding of the spring is once more effected. The batteries usually employed are those of Grove, thirty cups being necessary in a space of 150 miles, which may be either collected or distributed at intervals along the line. Only one wire is now used on the main line, the earth affording the return circuit. On the Baltimore and Philadelphia line the daily performance of one of Morse's machines is to transmit from 8000 to 9000 letters per hour. The best proof of the efficiency and economy of Morse's system is the fact, that it is employed on no fewer than fifty-six different railway lines in America, and extends over a length of 19,963 miles, or nearly nine times the whole extent of the English telegraphs of all descriptions.

The next electro-magnetic telegraph, as regards date of publication, was that of Professor Wheatstone. In 1834, he published the results of a series of experiments on the velocity of electricity, and in 1836 repeated his experiments at King's College, in which he employed an insulated circuit of copper wire, about four miles in length. In 1837, Professor Wheatstone, in conjunction with Mr. W. F. Cooke,, patented a telegraph, the principle of which was founded upon the discovery of Œrsted, of the deflecting influence of an electric current upon a magnetic needle; and consisted of a combination of several peculiarly-constructed galvanometer needles. Without troubling our readers with the descriptions of the first imperfect attempts of Wheatstone and Cooke, we will briefly explain their system as at present in use. Their transmitting instrument consists of a horizontal brass wheel, divided and marked on its upper surface like the disc of the telegraph, with which it exactly corresponds. The circumference of this wheel is cut away in twelve places, into which small pieces of ivory are let. A metallic spring in connection with the battery pressing against the circumference of the wheel when the wheel is turned round, is alternately in contact with the brass of which the wheel is composed and the ivory pieces, by which means the electric circuit is alternately completed and broken. Iron pins are inserted in the wheel corresponding to each letter, by which the wheel is caused to revolve to any extent required. Another modification of this instrument consists in connecting concentrically to the brass wheel having iron pins or handles, a toothed wheel, which gears into a small pinion, on the axis of which is affixed an armature of soft iron, surrounded with coils of copper wire. A strong spring, acting upon clockwork, imparts motion to the disc or index, the attraction of the armature being used to regulate the escapement, every current releasing a single tooth, and so advancing the disc one letter.

The receiving instrument consists of a similar arrangement of clockwork giving motion to a disc, on which the letters of the alphabet or other signals are marked. The escapement is also acted upon by the keeper or armature in a manner corresponding to that of the transmitting instrument. Thus every movement given to the brass wheel at the transmitting station is instantly repeated at the receiving station, thereby enabling messages to be conveyed with great rapidity, one letter only of the telegraphic disc being exposed to view at a time.

Cooke and Wheatstone's patents were purchased by the Electric Telegraph Company in 1846. The average number of words transmitted by their double-needle telegraph is about seventeen per minute, which is slow in comparison with either Morse's or the House telegraphs, which are capable of forwarding from thirty to thirty-five words per minute.

The next electro-magnetic telegraph in point of date was that of Professor Steinheil, a notice of which was published in 1836. His apparatus was adopted by the Bavarian government, and in operation in 1837. This was the the first telegraph in which the earth was employed as half the circuit. At Bogenhausen, the Royal Academy is connected to the Royal Observatory by a double-copper wire, the total length of which amounts to 32,506 feet, weighing 260 lb. In this instrument the deflection of the two magnetic bars or armatures is made to produce sound from metal or glass bells, whose notes differ about a sixth. To the north pole of one magnet and the south pole of the other are affixed little cups, with fine perforated beaks, that contain printing ink. In front of these beaks a flat surface of paper is kept moving. On the deflection of either of the magnetic bars, the beak of its cup, from which issues by capillary attraction a minute quantity of ink, is caused to touch the paper, and leaves thereon a round black dot. Different arrangements of four of those dots are ingeniously contrived to represent all the letters of the German alphabet most commonly used.

After Steinheil's came Alfred Vail's printing telegraph, which was proposed in 1837. It consisted of a type-wheel, having on its surface the twenty-four letters of the alphabet; on the side of this wheel were a corresponding number of holes. The type-wheel was caused to revolve by a spring, that caused an electro-magnetic key to advance; at each interruption and return of the current the paper was made to move under the type-wheel by means of clockwork. But as the precision of this instrument was dependent on the exact correspondence of the receiving with the transmitting instrument, and it was necessary that the type-wheel should present the same letter at both stations, this system was never put into execution.

A little time after Vail's telegraph was published, Alexander proposed a method of indicating signals by letters arranged systematically, and covered by small light screens, to each of which was attached a magnetic needle, connected to the battery by a separate wire. An electric current passed through one of these wires caused its needle to be deflected, which moved the screen and disclosed the particular letter it covered. This was also a complicated and non-efficient instrument, and accordingly has been little or never used.

After Alexander, Davy produced an ingenious contrivance, by means of which the electric current, acting upon a series of keys, eight of which were marked with three letters of the alphabet, caused slides or magnetic bars to be withdrawn from over any particular set of letters, which appeared illuminated to the spectator by a lamp properly arranged for that purpose. Three strokes on a bell drew the attention of the observer, and one stroke indicated the termination of each word, which was copied down by the observer just as represented.

In 1837, Professor Masson, of Caen, described, in a letter to the French Academy, the results of several trials he had made with a magneto-electric telegraph for a distance of 1800 feet. He employed the machine of Pixii to develope the currents that deflected magnetic needles placed at the extremities of the circuits. In 1838, Masson, together with Bréquet, experimented with this instrument, but failed to produce any satisfactory result.

Amyot, in 1838, addressed a letter to the Academy of Science at Paris, proposing to write on paper with mathematical precision by means of a single circuit and needle. The message was to be transmitted by a simple wheel, on which points or pins were adjusted, in a manner similar to those of a barrel organ; but this was only another abortive attempt at mechanical telegraphing.

In 1838, Edward Davy patented a method of employing the decomposing action of the galvanic current to produce marks upon chemically-prepared calico, treated to a solution of the iodide of potassium and muriate of lime. A local battery produced the telegraphic signs by chemical decomposition, and operated an electro-magnet, whose armature regulated a receiving instrument similar in principle to that of Cooke and Wheatstone, with the exception that the circuit was closed by the contact of metals instead of mercury, in the same manner as the Morse instrument. The main circuit was opened and closed by finger-keys; when closed the needle was deflected, which closed the short circuit; but when interrupted, the needle opened the short circuit by returning to. its original position. The prepared calico was drawn between a metallic cylinder and a series of platinum rings surrounding a wooden cylinder; by these rings the current from a local battery passed through the calico to the cylinder beneath, producing signs consisting of simple dashes, arranged in six rows,—the calico was caused by clockwork to move in proportion to the number of signs transmitted. The platinum rings could be connected at will with the other poles of the battery, but were insulated from each other. Three telegraphic wires, by means of a commutator, connected the local battery with either of the six platinum rings. An exceedingly ingenious escapement regulated the movement of the paper, but we must refer our readers to the work of Dr. Turnbull for a description of it.—We shall continue our history of telegraphing and review in our next Number.

*Railway Wheels.*—Mr. W. B. Adams, C.E., has patented an improvement in railway wheels, which consists in constructing them with a disc body of timber, formed of wedge-shaped pieces dowelled or tongued-and-grooved together and turned down in a lathe, so that the wheel is made thinner at its edge than at its centre.

## AMERICAN RIVER AND CANAL NAVIGATION.*

Immediately after the acknowledgment of the independence of the American colonies by England in 1783, several companies were formed in the two principal states of the Union, those of New York and Pennsylvania, for the purpose of constructing a system of canals. These enterprises were accordingly commenced, but on a scale too limited for the attainment of the ultimate objects; and as the United States advanced in commercial prosperity, more extensive plans were adopted. In 1807, the senate charged the Secretary of State, Mr. Galatin, to prepare a project for a general system of intercommunication by canals, based upon the geographical character of the territory of the Union. A system of artificial water-communication was accordingly projected, which, with some modifications, was at a later period adopted and carried into execution. These projects, however, suffered an interruption from the renewal of the war in 1812; and it was not until five years later that the vast works were commenced, the result of which has been a system of inland navigation which is without a rival in any country in the world.

On the anniversary of the declaration of independence celebrated the 4th July, 1817, the commencement of the great line of canal connecting the Hudson with the Lake Erie was inaugurated. The river Hudson presented a navigable communication for vessels of a large class from New York to Albany. The object of this line of canal was to open a water-communication between Albany and the northern lakes, so as to connect, by continuous water-communication, the North-western States with the Atlantic. In less than eight years this work was accomplished by the state of New York, with its exclusive resources. That state alone executed and brought into operation the largest canal in the world. As first constructed, the Erie canal, with its branches, cost 2,600,000*l*. sterling; but its magnitude and proportions being still found inadequate to the exigencies of a continually increasing traffic, its enlargement was decided upon in 1835, and it was finally completed, at a cost of upwards of 5,000,000*l*. sterling. The total length of this canal is 363 miles, and its cost of construction per mile was therefore about 13,700*l*.

Meanwhile, the other states of the Union did not remain inactive. Pennsylvania especially rivalled New York in these enterprises, and became intersected with canals in all directions. In short, these works were undertaken to a greater or less extent, in most of the Atlantic and some of the Western States; and the American Union now possesses a system of internal artificial water-communication amounting to nearly 4500 miles, executed with a degree of skill and perfection rarely surpassed by any similar works constructed in the states of Europe.

According to M. Michel Chevalier, whose work on this subject supplies most voluminous and valuable details, the extent of canals which were in operation in the United States on January, 1, 1843, was 4333 miles. There was a further extent projected, but not executed, amounting to 2359 miles. The total cost of executing the canals which were completed was, according the M. Chevalier, 27,870,964*l*. being at the average rate of 6432*l*. per mile.

Since the date of these returns considerable extension has been given to the system of canal navigation by the opening of new lines and the increased length of former ones, and it is probable that the actual extent of artificial water communication now in use in the United States considerably exceeds 5000 miles. The average cost of executing this prodigious system of water-roads was at the rate of 6432*l*. per mile, so that 5000 miles would have absorded a capital of above 32,000,000*l*.

This extent of canal transport, compared with the population, exhibits in a striking point of view the activity and enterprise which characterise the American people. In the United States there is a mile of canal navigation for every 5000 inhabitants, while in England the proportion is a mile to every 9000 inhabitants, and in France a mile to every 13,000. The ratio, therefore, of this instrument of intercommunication in the United States is greater than in the United Kingdom, in proportion to the population, as 9 to 5, and greater than in France in the ratio of 13 to 5.

The river navigation of the United States is on a scale commensurate with the extent of their territory. The division of the country east of the Alleghanies, forming the Atlantic States, is drained by a vast number of rivers, of the first and second class, all navigable for vessels of considerable burthen, the principal of which are the Hudson, the Delaware, the Susquehanna, the Connecticut, the Potomac, the James, the Roanoke, the Savannah, and, to the southwards, the Atamala, and the Alabama.

The steam navigation of the Hudson is entitled to attention, not only because of the immense traffic of which it is the vehicle, but because it forms a sort of model for most of the rivers of the Atlantic States. This navigation is conducted, as will be seen, in a manner and on a principle altogether different from that which prevails on the Mississippi and its tributaries.

In the steam-vessels used on these rivers, no other strength or stability is required than is sufficient to enable them to float and bear a progressive motion through the water. Not having to encounter the agitated surface of an open sea, they are supplied with neither rigging nor sails, and are built exclusively with a view to speed. Compared with sea-going steamers, they are slender and weak in their structure, with great length in proportion to their beam, and a very small draught of water.

The position and form of the machinery are affected by these circumstances. Without the necessity of being protected from a rough sea, the engines are placed on the deck in a comparatively elevated situation. The cylinders of large diameter and short stroke, almost invariably used in sea-going ships, are rejected in these river boats, and the proportions are reversed,—a comparatively small diameter and a stroke of great length being adopted. It is but rarely that two engines are used. A single engine, placed in the centre of the deck, drives a crank placed on the axis of the enormous paddle-wheels. The great magnitude of these latter, and the velocity imparted to them, enable them to perform the office of fly-wheels, and to carry the engine through its dead points with but little perceptible inequality of motion. The length of stroke adopted in these engines supplies the means of using the expansive principle with great effect.

The new and largest class of steamers are capable of running from twenty to twenty-two miles an hour, and make, on an average, eighteen miles an hour. These extraordinary speeds are obtained usually by rendering the boilers capable of carrying steam from forty to fifty pounds pressure above the atmosphere, and by urging the fires with fanners, worked by an independent engine, by which the furnaces can be forced to any desired extent.

It is right to observe here that this extreme increase of speed is obtained at a disproportionately increased consumption of fuel. When the speed is increased, the space through which the vessel must be propelled per minute is increased in the same proportion: and, at the same time, the resistance which the moving power has to overcome is augmented in the proportion of the square of the speed. Hence, the effect to be produced by the moving power per minute, is increased by two causes; first, the actual resistance which it has to overcome is augmented in the ratio of the square of the speed; and, secondly, the space through which the moving power has to act against this resistance in each minute is increased in the ratio of the speed. Thus, the total expenditure of moving power per minute will be augmented in the proportion of the cube of the speed. It is found in some cases that the increase of three or four miles an hour on eighteen miles will cause nearly triple the consumption of fuel.

Much of the efficiency of these engines arises from the application of the expansive principle; but to this there has been hitherto a limit, owing to the inequality of the action of the piston when urged by expanding steam on the crank. When the steam is cut off at less than half-stroke, the force of the piston is diminished before the termination of the stroke to less than one half its original amount. This inequality is aggravated by the relative position of the crank and connecting-rod, the leverage diminishing in nearly the same proportion as the power of the piston diminishes. On this account it has not been found generally practicable to cut off the steam at less than half-stroke.

The steam is universally worked with expansion, the valves for its admission and emission being moved independently of each other. A separate engine is genenerally provided for driving the blowers, and a cylindrical fan-blower is employed for each boiler. Some of these blowers are 10 feet in diameter, being driven by a crank placed on their axle, which receives its motion from the small independent engine.

The great power developed by these river engines is due not so much to the magnitude of their cylinders, as the pressure of steam used in them. Some of the most recently constructed boats have cylinders 76 inches in diameter, and 15 feet stroke. The steam has 40 lb. pressure in the boiler, and is cut off at half-

* From the 'Museum of Science and Art'; Part IV. Edited by Dr. Lardner. London: Walton and Maberly, 1854.


Fig. 1.

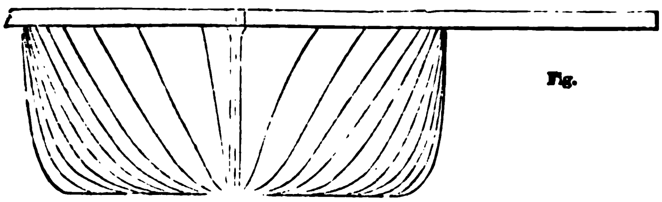


Fig.

Fig. 2.

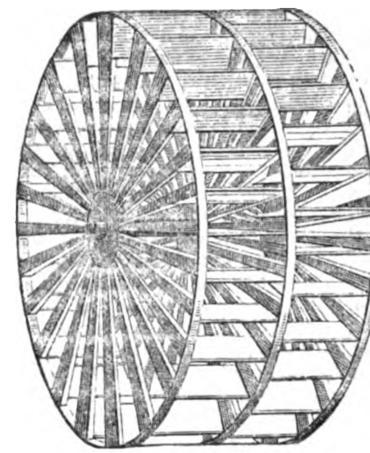


Fig. 3.

stroke. The wheels, which are 45 feet in diameter, make sixteen revolutions per minute. The speed of the circumference of the wheel will therefore be twenty-five miles an hour; so that if the speed of the boat be twenty miles an hour, we have the difference, five miles, giving the relative movement of the edge of the paddle-boards through the water.

The increase of the dimensions of these vessels and of their machinery has been attended with a greatly augmented economy of fuel; while practical evidence of economy is also supplied by the fact that the proprietors of the Hudson steamboats reduced their tariff for passengers, as well as for freight, as they increased the size of their vessels.

The ease with which these vessels of extraordinary length and beam and small draught move through the water is very remarkable. The results of their performance show that the resistance per square foot of immersed midship section is not perceptibly increased by the increased length of the vessel, and the consequently augmented surface and friction. This anomaly has not been explained, but it is certain that the increased length does not diminish the effect of the moving power in any perceptible degree.

The form and structure of these river-steamers will be more easily understood by fig. 1 of the annexed engravings, which represents a side elevation of one of the Hudson steamers, and fig. 2 is a cross section of the hull with one-half of the platform, which is placed upon it, and which supports the upper cabins and saloons. This hull is constructed with a perfectly flat bottom and perpendicular sides, and is rounded at the angles. At the bow or cutwater they are made very sharp.

The split paddle-wheel, which until very lately was exclusively used in these boats, is represented in fig. 3, and is formed as if by the combination of two or more common paddle-wheels, placed one outside the other, on the same axle, but so that the paddle-boards of each may have an intermediate position between those of the adjacent one, as represented in fig. 2.

The spokes, which are bolted to cast-iron flanges, are of wood. These flanges, to which they are so bolted, are keyed upon the paddle-shaft. The outer extremities of the spokes are attached to circular bands or hoops of iron, surrounding the wheel, and the paddle-boards, which are formed of hard wood, are bolted to the spokes. The wheels thus constructed, sometimes consist of three, and not unfrequently four, independent circles of paddle-boards, placed one beside the other, and so adjusted in their position that the boards of no two divisions shall correspond.

The other class of steamers used for towing the commerce of the rivers corresponds to the goods trains on railways. No spectacle can be more remarkable than these locomotive machines, dragging their enormous load up the Hudson. They may be seen in the midst of this vast stream, surrounded by a cluster of twenty or thirty loaded craft of various magnitudes. Three or four tiers are lashed to them at each side, and as many more at their bow and at their stern. The steamer is almost lost to the eye in the midst of this crowd of vessels which cling around it, and the moving mass is seen to proceed up the river, no apparent agent of propulsion being visible, for the steamer and its propellers are literally buried in the midst of the cluster which clings to it and floats round and near it.

As this *water goods train*, for so it may be called, ascends the Hudson, it drops off its load, vessel by vessel, at the towns which it passes. One or two are left at Newburgh, another at Powkeepsie, two or three more at Hudson, one or two at Fishkill, and, in fine, the tug arrives with a residuum of some half-dozen vessels at Albany.

## ON THE ROTATION OF THE PENDULUM.

By Alfred Day.

Having been one of the parties who, in an early stage of the inquiry, proposed a simple original solution of this phenomenon of the rotation of the pendulum, which is now commonly adopted without acknowledgment, and which has been again and again repeated both here and in America, I am desirous of correcting some unsatisfactory representations which still find their way into print in works of a respectable class. I refer to the account given of the problem in a manual of the physical sciences by Dr. Golding Bird and Mr. Brooke, where the correct explanation is also given, being exactly the same as my own, even to the form in which the trigonometrical relation is expressed, the same fraction, $\frac{\cos.\ \lambda}{\cot.\ \lambda}$, occurring in both. But this explanation is accompanied, or rather prefaced, by some remarks, which represent the problem, first, as having excited much more attention than it deserved; next, that the rotation of the pendulum is not an immediate effect of the earth's rotation; and thirdly, that the rotation of the pendulum is only an *apparent* rotation. Now on this I cannot help remarking, that the problem would have been most interesting, and deserving all the scientific examination it received, if only as a purely speculative or abstract one; and it was remarkable that the precise case had never been discussed. As it was, it took mathematicians by surprise, baffled not a few respectable professors of the science, and was wrongly apprehended by several analysts of considerable eminence. None of the analytical solutions, if such they can be termed, that have from time to time appeared in this country, have established

* From the 'Philosophical Magazine.'

anything more than is done with far greater clearness and simplicity by the explanation given in the work referred to; and the whole thing, notwithstanding its great interest and novelty, has sunk into temporary contempt and neglect, as if the scientific republic was rather ashamed of having allowed so much discussion and so much algebra to be wasted on a thing so readily demonstrable by a person tolerably conversant with Euclid only, or, to say the least, with Euclid and the first elements of plane trigonometry. By way of retaliation, there is no glory to be got out of it, the problem is now never mentioned, and a large body of people at this moment look upon the whole thing as tacitly given up, notwithstanding that the exact experiments of Mr. Bunt, certainly undertaken with no bias in favour of bringing out the precise result, have proved it, in a great variety of trials, to be true in practice, which is by no means necessary to establish the truth of theoretic reasoning. It is not, however, as a speculative case that the problem is of the highest interest, but as an immediate proof of the earth's motion round its axis; and the discovery was hailed as important chiefly on this ground by the members of the French Institute. It is true you do not see the earth's rotation any more than before, nor does the pendulum move away at a rate necessarily corresponding with that in which the former is performed. I may state the real value of the illustration thus. It is only within a comparatively recent period of the world's history that the apparent motion of the heavens has been finally reconciled with the supposition of a motion in the spectator on the earth's surface, and not in them; and while no objection can be raised against adequacy of this supposition to account for what is witnessed, there are a hundred reasons why it should be adopted implicitly, without one to be urged on behalf of the ancient hypothesis which makes the earth stand still. We have heard indeed of incredulity on this point, but it must be confined to those who, with their systems of philosophy or theology, stand as still as the earth on their theory; and to offer a serious refutation would be loss of time, without the hope of bettering the state of their convictions. Notwithstanding, however, that the mass of men are fully agreed on this question, and that the great conspiracy of arguments tends to render the conclusion in the highest degree probable, and to the philosopher certain, it cannot be denied that a diurnal rotation of the heavens would produce effects such as those ordinarily observed, and that the reasons which lie against it are not those which can be easily understood by persons unskilled in physical demonstration. We are glad then of a new fact, which, though it does not really make the rotation of the earth more a sensible phenomenon than before, shows that a relative motion exists between the earth and other independent planes, in which the same positions do not necessarily recur after twenty-four hours, and which are in no way affected by any rotation of the sidereal heavens, and yet are wholly explicable on the hypothesis of the earth's rotation round its axis in twenty-four hours, and on no other. To a person who views the pendulum experiment, the rotation of the plane of its vibration is readily and speedily manifest; and because this may be shown to depend on the rotation of the earth, it is not unnaturally designated a making the earth's rotation visible. We do not, however, apart from reasoning, attribute the effect observed to the motion of the earth, any more than we do the motion of the stars about us to that cause; for what we appear to see is strictly a motion of the plane of vibration round the zenith as a pole. It may suit the purpose of popular explanation to say that the plane of the pendulum's vibration remains unchanged while the earth rotates under it; but a little consideration shows that this is not strictly true, and the conception of what does take place becomes more difficult than in the case of the apparent motion of the heavens, since the pendulum being carried at its point of suspension with the earth, appears to be one with it. But though the earth's diurnal rotation is less directly proveable in this way, it is far more conclusively so than it is by the motion of the stars. In these last, the motion having existed from the commencement of all things, might have been originally impressed as well as that of the earth; but with the pendulum set in motion by human agency, and continuing to vibrate without solicitation to the right hand or left, on the supposition of the earth being at rest, no such apparent rotation could be brought about on any known physical law. It is, therefore, the earth that moves, not at the rate of the pendulum nor round the pendulum-wire when at rest as an axis, though this it might do if this were consistent with the observed motion of the stars; but round another axis pointing to another star, and at a rate coinciding with the apparent rate of the sidereal revolutions. It is therefore a sensible proof of another kind than any previously known to exist, and of directly sensible proofs measured by the eye in short intervals of time, the most conclusive in its kind.

The value of the whole argument may be thus stated. Either the heavens or the earth rotate once in twenty-four hours, or both move by a joint motion away from each other equivalent to this in amount; and either of these conditions is abstractedly possible, so that no conclusion can be drawn. In this latitude the pendulum rotates in about thirty hours, or the earth in twenty-four; and as there can be no assignable reason why the former should do this without a cause, the rotation of the earth in twenty-four is a fact for the rational being, since it is clear that no supposition of the observed motion being partly in the earth and partly in the heavens will fulfil the second set of conditions. The experiment of the pendulum is, therefore, very correctly designated as a making visible the earth's rotation, though hardly in the sense popularly attached to it: its importance cannot, we think, be overrated. So much then for the second objection; and I shall now proceed to show that the rotation is to all intents and purposes real, and not merely apparent on the part of the vibrating plane. I have elsewhere, in a published diagram, shown that the pendulum's actual rotation is the resultant of two sets of continually-exerted forces, one tending to keep the pendulum swaying parallel to itself, the other to make its point of suspension and the line which the pendulum would occupy if at rest rotate obliquely to the axis of the two circles described by the point of suspension and the ball at the mean of the oscillation. Shortly after the publication in question, I constructed a simple mode of illustrating the fact. Cut out two circular discs of card, and make an equal number of cogs or teeth in the rim of each. Paste one of these on a larger circular disc and concentric with it, and cut both through along any radius from the circumference to the centre. If now we draw a diameter on the other toothed disc, and cause it travel round by placing the teeth of the two discs in one another in the manner of ordinary wheels when acting on each other, but so that the larger disc shall remain motionless, we shall find that this line will have rotated once for one entire revolution of the moving wheel round the circumference of the fixed one. If now we coil up the large disc with its attached rack into the shape of a cone, so as to hide some of the teeth, our index-line will not rotate once during the revolution of its disc over the entire surface of the rack on the conical surface; and the more acute the cone is, the smaller the amount of rotation. This is not only analogous to the case of the pendulum, but it is exactly the same in amount, when the plane sectional angle of the cone is altered proportionally to the latitude of the place where the pendulum is set swinging.

Great confusion has arisen in many minds with reference to this problem from not separating two things, a free and a constrained and conditioned motion, and not distinguishing what is real from what is apparent. Thus, if a cone be set revolving on its axis, a fixed straight line on the surface of the cone will, after one entire revolution, be in the same spot, and we say of it that it has not rotated round any point in itself; but yet if a plane be conceived to pass through the line in its first position and the axis of the cone, and the projection of the line after a quarter revolution falling perpendicular on this plane be drawn, the two lines will cut one another at an angle equal to half the plane sectional angle of the apex of the cone, and in half a revolution this angle will be doubled. The partial rotation, however, in the first half of its course, which reaches its maximum in half a revolution of the cone, is in fact retrograde during the second half, and at the completion of the whole period all things are as they were. The whole of this is a constrained motion, during which every point in the line moves in a circle, but every point with a velocity different from that of its neighbour and in a different circle. This is totally different from the case of a line occupying at each infinitesimally-consecutive instant a position parallel to itself, and thus having all its points moving uniformly in equal circles, or constrained to keep to the surface of the revolving cone, so as to cross always a given point on it, or, in other words, moving at the same rate as the cone. It has been sufficiently and irrefragably demonstrated, that while the cone continues to revolve in the same direction, the line so circumstanced would constantly rotate in one direction round that point which it always crosses; and that though this result is obtained by the tendency of the line to keep parallel to itself, coupled with the constraint applied to it, it will not, after a complete revolution of the cone on its axis, bring the line into parallelism with its first position, but only after the lapse of a longer period. Hence the rotation is real, not merely *apparent*; and were there no apparent rotation, there must have been a real retrograde force of rotation applied to the plane of oscillation, so as to have obliterated all the advance we actually see in practice. I have met with other gentlemen of mathematical education and reputation, who have persisted in calling this rotation an apparent one, which it certainly is, and something more.* When we talk of the apparent rotation of the heavens, we mean that they do not revolve, but only the earth, in twenty-four hours, all things being replaced. If the earth really revolves in twenty-four hours, it is certain that the oscillation of the pendulum is not in the same direction; and consequently it has rotated; unless any one is absurd enough to maintain that the rotation of the earth itself varies its period at different latitudes.

* There is no rotatory tendency in the plane of oscillation, excepting in so far as this is produced as a result of the earth's constraint on the point of suspension; in other words the rotatory effect is due to the earth. In this sense it is the earth's rotation made visible, though the angular motion is slower than that of the earth; and the case may be compared to the motion of the box containing the main-spring of a watch, as evidenced by the motion of the hands.

## ON DR. STENHOUSE'S CHARCOAL RESPIRATOR.

By Dr. G. Wilson.

[*Paper read at the Royal Scottish Society of Arts, June 19th* 1854.]

Dr. Wilson commenced by stating, that having read with much interest the account of Dr. Stenhouse's researches on the deodorising and disinfectant properties of charcaal, and the application of these to the construction of a new and important kind of respirator, he had requested that accomplished chemist to send one of his instruments for exhibition to the Society, which he had kindly done. Two of the instruments were now on the table, differing, however, so slightly in construction that it would be sufficient to explain the arrangement of one of them. Externally, it had the appearance of a small fencing-mask of wire-gauze, covering the face, from the chin upwards to the bridge of the nose, but leaving the eyes and forehead free. It consisted, essentially, of two plates of wire-gauze, separated from each other by a space of about $\frac{1}{4}$ or $\frac{1}{8}$-inch, so as to form a cage filled with small fragments of charcoal. The frame of the cage was of copper, but the edges were made of soft lead, and were lined with velvet, so as to admit of their being made to fit the checks tightly, and enclose the mouth and nostrils. By this arrangement no air could enter the lungs without passing through the wire-gauze, and traversing the charcoal. An aperture is provided with a screw or sliding valve, for the removal and replenishment of the contents of the cage, which consists of the siftings or riddlings of the lighter kinds of wood-charcoal. The apparatus is attached to the face by an elastic band passing over the crown of the head, and strings tying behind, as in the case of the ordinary respirator.

The important agent in this instrument is the charcoal, which has so remarkable a power of absorbing and destroying irritating and otherwise irrespirable and poisonous gases or vapours that, armed with the respirator, spirits of hartshorn, sulphuretted hydrogen, hydrosulphuret of ammonia and chlorine, may be breathed through it with impunity, though but slightly diluted with air. This result, first obtained by Dr. Stenhouse, has been verified by those who have repeated the trial, among others by Dr. Wilson, who has tried the vapours named above on himself and four of his pupils, who have breathed them with impunity. The explanation of this remarkable property of charcoal is twofold. It has long been known to possess the power of condensing into its pores gases and vapours, so that if freshly prepared and exposed to these, it absorbs and retains them. But it has scarcely been suspected till recently, when Dr. Stenhouse pointed out the fact, that if charcoal be allowed to absorb simultaneously such gases as sulphuretted hydrogen and air, the oxygen of this absorbed and condensed air rapidly oxidises and destroys the accompanying gas. So marked is this action, that if dead animals be embedded in a layer of charcoal a few inches deep, instead of being prevented from decaying, as it has been hitherto supposed they would be by the supposed antiseptic powers of the charcoal, they are found by Dr. Stenhouse to decay much faster, whilst at the same time no offensive effluvia are evolved. The deodorising powers of charcoal are thus established in a way they have never been before; but at the same time it is shown that the addition of charcoal to sewage-refuse lessens its agricultural value contemporaneously with the lessening of odour. From these observations, which have been fully verified, it appears that by strewing charcoal coarsely powdered, to the extent of a few inches, over churchyards, or placing it inside the coffins of the dead, the escape of noisome and poisonous exhalations may be totally prevented. The charcoal respirator embodies this important discovery. It is certain that many of the miasmata, malaria, and infectious matters which propagate disease in the human subject, enter the body by the lungs, and impregnating the blood there, are carried with it throughout the entire body which they thus poison. These *miasms* are either gases and vapours, or bodies which, like fine light dust, are readily carried through the air; moreover, they are readily destroyed by oxidising agents, which convert them into harmless, or at least non-poisonous, substances, such as water, carbonic acid, and nitrogen. There is every reason, therefore, for believing that charcoal will oxidise and destroy such miasmata, as effectually as it does sulphuretted hydrogen or hydrosulphuret of ammonia, and thus prevent their reaching and poisoning the blood. The intention accordingly is, that those who are exposed to noxious vapours or compelled to breathe infected atmospheres, shall wear the charcoal respirator, with a view to arrest and destroy the volatile poisons contained in these.

Some of the more obvious applications of the respirator were then referred to:—1. Certain of the large chemical manufacturers in London are now supplying their workmen with the charcoal-respirators as a protection against the more irritating vapours to which they are exposed. 2. Many deaths have occurred among those employed to explore the large drains and sewers of London, from exposure to sulphuretted hydrogen, &c. It may with confidence be asserted that fatal results from exposure to drainage-gases will cease as soon as the respirator is brought into use. 3. In districts such as the Campagna of Rome, where malaria prevails, and to travel during night, or to sleep in which, is almost certainly followed by an attack of dangerous and often fatal ague, the wearing of the respirator for even a few hours may be expected to render harmless the marsh poison. 4. Those who, as clergymen, physicans, or legal advisers, have to attend the sickbeds of sufferers from infectious disorders, may, on occasion, avail themselves of the protection afforded by Dr. Stenhouse's instrument during their intercourse wlth the sick. 5. The longing for a short and decisive war has led to the invention of "a suffocating bomb-shell," which, on bursting, spreads far and wide an irrespirable or poisonous vapour; one of the liquids proposed for the shell is the strongest ammonia, and against this it is believed that the charcoal-respirator may defend our soldiers. As likely to serve this end, it is at present before the Board of Ordnance.

Dr. Wilson stated, in conclusion, that Dr. Stenhouse had no interest but a scientific one in the success of the respirators. He had declined to patent them, and desired only to apply his remarkable discoveries to the abatement of disease and death. Charcoal had long been used in filters, to render wholesome poisonous water; it was now to be employed to filter poisonous air.

## SUB-ARCH TUNNELS

We have received a letter from Mr. Austin, respecting his plans of drainage, &c., drawings of which he exhibited at the meeting of the Institute of British Architects, in which he states that the idea of sub-archways was one entirely original with himself, and that he had no previous knowledge of any similar proposition.

This may be very true, as is the case with many other ideas; yet still the individual who first publicly makes known any scheme or invention has the *jus priores* to be considered as its originator.

We wish not to detract from the credit due to Mr. Austin for his proposition, which is not only practicable, but can be demonstrated to be in the end cheaper than the present imperfect patchwork system of drainage, &c.

He wishes us to correct the dimensions given of his tunnel, which, instead of being proposed to be 26 feet in height by 18 feet in width, should be 26 feet by 24 feet. We may probably notice Mr. Austin's scheme next month.

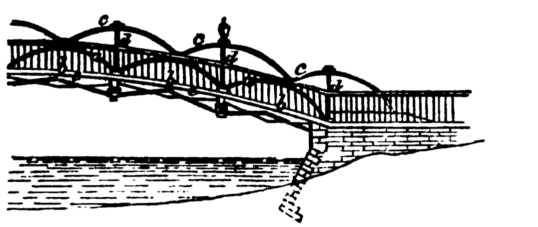
## CONSTRUCTION OF BRIDGES AND VIADUCTS.

JOHN MACINTOSH, *Patentee*, August 3, 1853.

THIS novel method of constructing bridges and other similar structures consists in combining a series of bow and string arches into one girder or beam, in such manner that each bow or arch springs from the crowns of the two bows or arches to which it is connected. And in constructing and repairing arches, particularly in rivers and waterways, in place of having piers and foundations, and springing the arches from and supporting the arches by such piers, inverted metal arches are used to support the arches above.

Fig. 1 of the annexed engravings is the side elevation of a bridge constructed in accordance with this invention. *a, a, a,* are a series of bows having their extremities tied in by rods *b, b,* as shown. *c, c, c,* is an upper tier of bows having their bearing upon the crowns of the arches or bows *a, a,* to which they are firmly fixed in such manner as to form a strong girder; the roadway *e,* is suspended by rods *d, d,* or otherwise to the bows *a, a, c, c,* as shown.

FIG. 1.



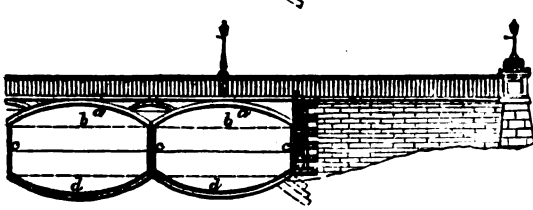


FIG. 2.

Fig. 2, is a side elevation of another form of bridge. The bows *a, a,* having strings *b, b,* are connected together and to vertical supports *c, c,* and the roadway *e, e,* is supported or laid on the crowns of the bows *a, a*; the vertical supports *c, c,* are at their lower ends connected together by inverts *d, d,* which lie at the bottom or bed of the river or other stream suitably prepared to receive them. By this means bridges can be constructed without the necessity of forming cofferdams; and the inverts may be temporarily tied with strings *b, b,* similar to those of the bows *a, a,* and the ends closed water-tight so as to float the parts to their destination, and then to remove the water-tight ends and sink the parts to the bed or bottom of the river or other channel over which the bridge is to be constructed. The several portions of the bridge each being formed of the parts *a, b, c, d,* are, after being sunken to the bed of the river and properly set in position, firmly secured together, after which the roadway and side railing are placed and affixed as usual, and the strings *b,* of the bows *a,* and inverts *d,* may then be removed so as to allow of the full dimensions of the arch formed by the bows *a,* and the inverts *d,* being clear for the passage of traffic.

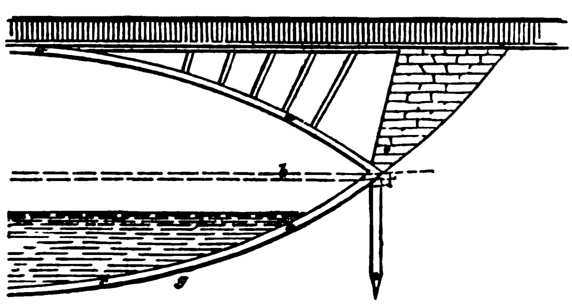


FIG. 3.

Fig. 3 shows a side view of another description of bridge. Instead of employing bows *a, a,* alone, as shown in fig. 1, the bows are connected, the one being inverted to the other, firmly united together at their ends, and strings or tie-rods placed across to stiffen the parts during the floating of them to their destination, after which and the filling in of the masonry, &c., at *e, f,* and the bed of the river at *g,* will be then sufficient to prevent the bows *a,* and inverts *c,* from becoming displaced.

The materials to be used in the construction of the bows and inverts and supports, may be of iron or wood or iron and wood combined, according as the dimensions or span of the bridge require.

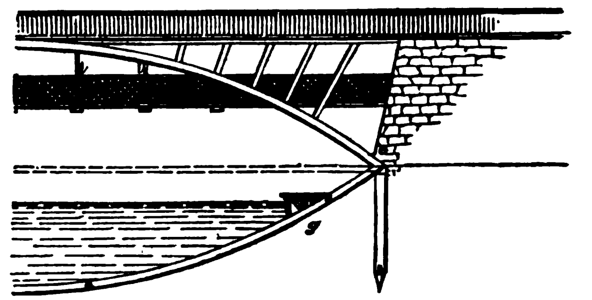


FIG. 4.

Fig. 4 shows a side view of a bridge of somewhat different form to either of the above described, in which the rods *i, i,* from the bows *a, a,* are made to sustain a road or footway bridge, in which case the bridge above at *h,* may be a railway bridge or suitable for any other purpose, and the bridge below being suspended therefrom by rods *i, i,* as shown, may be a roadway or footway bridge, or both, as desired.

*Claim.*—The modes of constructing bridges by forming and connecting bow and string arches into girders or beams. Also, the constructing and repairing arches without the ordinary abutments by using inverts, as herein explained.

## STEAM ENGINES.

GEORGE LEEDHAM FULLER, *Patentee*, August 17, 1853.

IN the ordinary form of compound engines, commonly known as double-cylinder condensing engines, the steam is allowed to expand from the first supply cylinder into one or more working conjointly with it, as regards the times or periods of stroke (as in Woolf's, MacNaught's, or Miller's patents), thus forming only, in effect, a single engine, with but small advantages over the plan of expansion in a single cylinder, and being considerably more costly in construction.

The novelty of this invention consists in an arrangement for expanding into and supplying two or more cylinders connected with a condenser and air pump, or condensers and air-pumps, in the usual ways, from one or more cylinders, supplied direct from the boiler, such supply and exhaust cylinders respectively not, as heretofore, having their pistons arriving at the top and bottom of their strokes conjointly, but being so arranged as regards their times and periods of action as to form together a complete rotary power.

Three cylinders will be found most economical, both as regards first cost and working, and for facility of arrangement. They are arranged in line, or at any convenient angle, as required, and are so adapted that one cylinder shall be in course of being supplied and two exhausted, and *vice versâ*.

For marine purposes, also, such engines afford peculiar advantages for provision in case of accidents to either of the cylinders or their respective parts, since a simple provision for cutting off the connection between the cylinders, and of connecting instead the exhaust passages and the ports of the supply cylinder, and the steam passages and the ports of the exhaust cylinders respectively, at once renders each cylinder an independent engine as regards its working, to which might also be added, if required, the provision of a second keyway to the crank, so as to give the power of placing the cranks of either two cylinders at any time at the usual working angle as regards each other, should the remaining cylinder become disabled.

The relative positions of the cylinders, the angles at which the cranks are placed, the proportion of areas of the cylinders to one another, the number and description of steam cylinders employed, whether direct action, side lever, beam, or vibrating, may be varied at pleasure. Nor does the inventor fix any particular times of the respective strokes for cutting off, which may or may not be made different for each cylinder, and such supply may or may not be continued to the end of the stroke, or may be variable by means of an expansion-valve in the ordinary way, at pleasure. Neither to any particular form of valve for such engine, or to the entrance and exit ports of the cylinders being the same or separate; but claims as new all and every arrangement and form of steam-engine, wherein steam being supplied to one or more cylinders, passes from it or them into two or more other cylinders, discharging into a condenser in the usual or any other manner, and so arranged in connection with the said supply cylinder or cylinders, as regards their times of action, that the whole cause a continuous rotary motion to a common driving-shaft, instead of having only, as in the present arrangement of such compound engines, the effect of a single engine, thus combining all the economical advantages of an unlimited power of expansion with the effect obtained by two or more separate engines.

The second part of this invention relates to the valves of vibrating engines. The steamways are continued through one of the trunnions, formed with a division in it, to separate the top and bottom steam-way respectively; on an enlargement of the trunnion are formed valve faces and ports, on which a segmental slide-valve can be worked for the purposes of lead and expansion, as in ordinary engines; thus substituting for the present method of having a steam-chest fixed on to and moving with the vibrating cylinder, and supplied and discharged through the two trunnions respectively—both of which require consequently to be furnished with stuffing-glands at their junctions with steam and exit pipes respectively, and so add greatly to the friction—a fixed steam-chest with passages through only one trunnion, and no absolute necessity (except sufficient to provide for any chance leakage of the valves) for any stuffing-glands at all; while at the same time the valve gearing, instead of being, as at present in such engines, comparatively complicated and expensive, is rendered as simple as that for ordinary fixed cylinder-engines. And moreover, by the motion of the cylinder being rendered available, the entrance and exit of the steam through the ports is quickened considerably while the required motion or throw of the valve need only be sufficient for the purpose of expansion and lead.

Under this second head, the inventor claims any arrangement whereby, by means of ports and faces formed on an enlargement of the trunnions of vibrating engines (whether such engines be condensing, non-condensing, or compound, and working within or against a properly-formed seat), steam is obtained from fixed steam-pipes, through a fixed steam-chest or valve-box, and let out in a similar manner; and to which faces and seats also segmental slide-valves, formed as herein described, can be applied and moved for the purposes of giving lead or cutting off steam, reversing, &c., in the same manner and with the same facility as the slide-valves of ordinary fixed cylinders.

## NOTES OF THE MONTH.

*Mr. Christopher.*—We regret to announce the death of Mr. James Charles Christopher, architect, on the 14th ult. It appears that the deceased, after partaking of an entertainment given to the Committee of the District Surveyor's Association, by Mr. Gutch, at Greenwich, proceeded to join his brother to witness the embarkation of the French troops at Calais destined for the Baltic. While his brother's vessel, the *Lizard*, was nearing the *Algiers* line of battle ship, her topmast got foul of the yards of the *Algiers*, and snapped, and the falling spar, in its descent on deck, struck the back part of deceased's head, and caused his instantaneous death. He was a member of the firm of Garland and Christopher, and was district surveyor of the parish of Hammersmith, which office he had held from the date of its first creation.

*Paper from Peat.* — A French chemist, J. Lallemand, has recently patented a method of manufacturing paper from peat or turf. The process consists in first thoroughly separating, by washing, all the earthy from the fibrous portions of the peat. The fibres are then placed in a bath of caustic ley. After a lapse of twenty-four hours, the fibres are removed to a bath acidulated with hydrochloric acid, in which they are agitated for about four hours. The fibres are next washed in clear water, and then again bathed in water containing a small quantity of alum. They are then bleached in a chlorine vat, and mixed with from five to ten per cent. of rag pulp, which mixture is placed in an ordinary pulping engine, and undergoes the processes usually adopted in the manufacture of paper.

*Spurious Coin Detector.*—An ingenious apparatus for detecting genuine from counterfeit coin has been proposed by a Mr. G. Davis, which, although simple, we are afraid will not come into very general use, as in these matters tradesmen and others mostly prefer relying on their own shrewdness, to employing mechanism liable to derangement. The apparatus in question consists of a gauge-plate let into the counter, having slots cut in it exactly corresponding to the diameter and thickness of the different varieties of coins. Beneath each slot is suspended a balance or lever, with an arm immediately under the opening, and exactly weighted to the precise weight of the coin. It is thus evident that this arrangement will readily pass genuine coins of the precise size and weight, whilst those that are not of standard weight will be unable to depress the lever, and those of greater diameter, which is generally the case with spurious coin, cannot be passed through the slot. The apparatus is best adapted for gold, as most of the silver currency is deficient in weight, yet perfectly genuine.

*Sydney Royal Mint.*—The whole of the machinery for the Sydney Royal Mint, consisting of two condensing steam-engines, rolling mills, machine for adjusting the thickness of metals, the cutting-out presses, coining presses, bars, furnaces, &c., have been shipped to Sydney. About eight months ago, the order for the machinery was awarded to Mr. Joseph Taylor, engineer, of Broad-street, Liverpool, by whom the whole has been completed to the entire satisfaction of the government. The cutting-out presses, and milling machines, are from new designs by Mr. J. Taylor, and have been successfully in work at the Royal Copper Mint, in that town, for some weeks.

*Railway Adaptation.*—Among the materialism carried by rail, *water* has come to take a place. The *Scottish Railway Gazette* observes, that the trains of the Morayshire Railway actually convey the pure fluid from Elgin to Lossiemouth to accommodate the summer visitors to that place. The fact is suggestive, trivial though it may seem. By means of interchanging commodities, or bringing commodities to a quarter where they are required, and where a money price may be had for the articles, a traffic of considerable value is obtained. This however, may to some extent, if not wholly, depend on the interposition of local railway officials, for it is to be recollected that to be profitable the railway system must not only secure the traffic already existing in a district, or that traffic to a great extent, but create more. By good management, by attending to diversified wants throughout districts and by suggesting the means of supplying these, a trade is likely to be got up which may bear on final results in a very favourable way.

*Soapstone.*—A new building material is coming into notice in New York which promises to supersede everything else. This is steatite or soapstone, either in its purest state or in combination with other rocks. Its common qualities are perfectly familiar. It is so soft that it can be cut with a chisel, planed, bored, sawed, or turned in a lathe. Yet it resists pressure very well indeed, particularly when mixed with the harder ingredients, such as hornblende or serpentine. In beauty it is often found equal to marble, with even a greater variety of appearance. It bears an excellent polish, and, if broken, can easily be mended, by using its own powder as cement, so nicely as to be detected only by a critical examination. A house of this material was built at Northampton in 1807, and it is said to be still standing fresh and clear, to all appearance as if it had encountered only the rains of our last watery spring. The stone may be heated to a white heat, and then gradually cooled, or plunged into cold water at the option of the experimenter—and in either case it does not shell off nor crumble. Wet granite, as we all saw at the burning of the Custom-house, positively explodes in the heat—the flutings of the pillars, for instance, leaping off two or three feet. If, therefore, soapstone should be employed for floorings as well as for walls (and there is no reason against it), a perfectly fireproof building would be the result. So if the assertions of all the chymists turn out to be correct, we have at last found out the very perfection of building materials. But they are testing the matter in New York, and we shall soon hear.—*American Paper.*

## COPPER, TIN, AND ZINC IMPORTS AND EXPORTS.

A Parliamentary paper has just appeared, containing returns of the quantities of copper, tin, and zinc imported and exported for the year ending on the 5th of January 1854. The total amount of copper ore imported into the United Kingdom within that period was 45,285 tons 19 cwt. 1 qr. 7 lb.—of which 29,049 tons 5 cwt. 0 qr. 19 lb. were imported into Swansea, 13,246 tons 8 cwt. 2 qr. 16lb. into Liverpool, and 2873 tons 1 cwt. 2 qr. 13 lb. into London. Of the entire amount, 14,606 tons 19 cwt. 2 qr. were imported from Cuba, 13,342 tons 3 cwt. 2 qr. 12 lb. from Chili, 4759 tons 5 cwt. 0 qr. 12 lb. from Spain, 3373 tons 10 cwt. 1 qr. 17 lb. from Peru, 2676 tons 15 cwt. 2 qr. 8 lb. from South Australia, 1322 tons 10 cwt. 3 qr. 25 lb. from New Zealand, 540 tons 0 cwt. 1 qr. 12 lb. from Van Dieman's Land; from the British North American Colonies 949 tons 4 cwt. 1 qr. 19 lb., and from the British West Indies and British Guiana 561 tons 15 cwt. 2 qr. 25 lb. The total quantity of British copper exported from the United Kingdom within the same period was 15,632 tons 7 cwt.; of which 6721 tons 12 cwt. were from the port of London, 6539 tons 17 cwt. from the port of Liverpool, and 1301 tons 11 cwt. from that of Swansea. Of this quantity 3799 tons 5 cwt. were exported to the United States of America, 3039 tons 16 cwt. to France, 1409 tons 10 cwt. to Holland, 940 tons 9 cwt. to the Hanseatic towns, 707 tons 14 cwt. to Belgium, 803 tons 0 cwt. 1 qr. to Italy, and 1815 tons 10 cwt. to the British possessions in India.

The entire quantity of tin imported into the United Kingdom in the same year was 2487 tons 0 cwt. 1 qr. 4 lb., besides 156 tons 14 cwt. 1 qr. 25 lb. of tin ore and regulus. Of tin, we received from Holland 587 tons 14 cwt. 1 qr. 11 lb., from the British territories in the East Indies, exclusive of Singapore and Ceylon, 548 tons 13 cwt. 2 qr., and from Singapore, 1155 tons 15 cwt. 3 qr. 15 lb. The quantity of tin exported from the United Kingdom within the same period was—British, 1277 tons; foreign, 1072 tons 10 cwt.

The quantity of zinc and zinc ore imported into the United Kingdom was 20,418 tons 19 cwt. 0 qr. 21 lb. of zinc, and 342 tons 6 cwt. 3 qr. 18 lb. of oxide of zinc, of which we received from Prussia 11,429 tons 0 cwt. 2 qr. 14 lb. of zinc, from the Hanseatic towns 7497 tons 14 cwt. 3 qr. 16 lb., and from Belgium 4011 tons 14 cwt. 3 qr. 4 lb.; and during the same period we exported from the United Kingdom 3181 tons 18 cwt. of British, and 9461 tons 4 cwt. of foreign zinc and zinc ore. In the foregoing abstract we have only given the most important places, the returns from others being, in many instances, very inconsiderable.

## NEW PATENTS.

### PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAW AMENDMENT ACT.

*Dated January 12, 1854.*

77. J. Serf, Paris—Improvements in seats or chairs for advertising

*Dated April 10.*

835. L. M. Trouble, Paris—Improvements in stamping-apparatus or autoperitype.

*Dated April 15.*

874. C. B. Goodrick, Old Kent-road—Improved artizan's tool, which may be used as a measuring-rule, straight edge, set square, T square, bevil, and plumb-rule

*Dated May 2.*

979. T. Jackson, Commercial-road, Pimlico—Improvements in the manufacture of paper from flax, hemp, jute, Indian grass, and other fibrous vegetable substances, or the tow produced from such fibrous substances.

*Dated May 10.*

1041. J. W. Hoby, Renfrew, and J. Milner, Stanley-street, Pimlico—Improvements in steam-engines

*Dated May 11.*

1049. H. Tylor, Queen-street—Improvements in chair-bedsteads

*Dated May 18.*

1106. T. C. Hine, Regent-street, Nottingham—New method of applying glass in the ornamentation of chandeliers and other fittings required for gas, candle, oil or other artificial light

*Dated May 29.*

1190. A. E. Sablons, South-street, Finsbury—Improvements in the construction of trunks, travelling-boxes, portmanteaus, and other similar receptacles

*Dated May 30.*

1194. A. E. L. Bellford, Castle-street, Holborn—Improvements in machinery for making bags of paper or other suitable material. (A communication)

*Dated May 31.*

1203. T. Harrison and E. Harrison, Blackburn, Lancaster—Improvements in looms for weaving

1205. G. A. De Penning, Calcutta—Appendage to screw-propellers

1207. A. Rogers, Beeston Royds, near Leeds—Improvements in the mode of ventilating mines, sewers, and other subterranean works, and likewise for the warming and ventilating of all kinds of public buildings

1210. L. I. Molinos and C. Pronnier—Improvements in locomotive steam-engines

1211. A. V. Newton, Chancery-lane—Improved mode of manufacturing soluble silicates. (A communication)

*Dated June 1.*

1213. J. Whitaker and J. Pickles, Todmorden, York—Improvements in machinery or apparatus for opening, cleaning, and preparing cotton, wool, or other fibrous substances

1215. C. King and E. S. Benfield, Chenies-street—Improved machinery for cutting and carving wood, stone, and other materials

1217. J. T. Chance, Birmingham—Improvements in machinery for roughing or preparing the surfaces of glass. (A communication)

1219. J. Robinson, Denton-mill, Carlisle—Improvements in apparatus for mixing wheat and other grain and matters

1221. G. K. Geyelin, Camden-town—Improvements in furnaces and fireplaces for facilitating the consumption of smoke

*Dated June 2.*

1223. C. Maschwitz, Birmingham—New or improved instrument for paring and slicing apples, potatoes, and other fruits and roots. (A communication)

1225. E. O. W. Whitehouse, Brighton—Improvements in effecting telegraphic communications

1227. E. Websky, Wustewaltersdorf, Prussia—Improvements in bleaching. (Partly a communication)

1229. J. Mason and L. C. Koeffler, Rochdale, Lancaster—Improvements in scouring and in washing wool, hairs, and yarns, and in machinery or apparatus for effecting the same

*Dated June 3.*

1231. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improved fuel. (A communication)

1233. T. Lenox, Pigott-street, Limehouse—Novel mode of reefing topsails, jibs, and other sails from the decks of ships while at sea

1235. A. H. Leplay, Douvrin, France—Improvements in extracting and manufacturing the alcohol of beetroot, and of other sweet matters or tubers

1237. W. E. Newton, Chancery-lane—Improvements in breech-loading fire-arms. (A communication)

1239. A. F. Goodnow, New York—Improvement in scythe snaths, or in the manufacture thereof. (A communication)

1241. A. G. Barham, Bridgewater, Somerset—Apparatus for damping or moistening the adhesive surfaces of stamps or labels.

*Dated June 5.*

1243. R. A. Brooman, Fleet-street—Improvement in screw-propellers. (A communication)

1245. G. Garbert, Port Louis, Mauritius — Improvements in the construction of buildings

1247. N. Neron, Rue St. Lazare, Paris—Improvements in muskets, carbines, fowling-pieces, and other fire-arms. (A communication)

1249. A. Spottiswoode, New-street, St. Bride's—Improvements in the manufacture of fuel

1251. T. Spiller, Red Lion-square, Holborn—Improvements in propelling carriages when atmospheric air is used

*Dated June 6.*

1253. W. J. Baillie, Southwark—Improved mode of propelling ships and other floating vessels

1255. J. Nicholson, Blackwall—Improved ratchet-screwing and drilling-stock, which may also be used as a spanner

*Dated June 7.*

1258. J. Mansfield, Stoke Stafford—Improvement or improvements in steam-boilers

1259. C. A. Perpigna, Paris—Improved apparatus for effecting the combustion of smoke in fireplaces. (A communication)

1260. W. E. Newton, Chancery-lane—Improved manufacture of bonnets and other coverings for the head. (A communication)

1261. P. Hindle, Ramsbottom, Lancaster—Improvements in power-looms for weaving

*Dated June 8.*

1262. J. Wilson, Albert-place, Stratford—Improved pump applicable to mines, wells, ships, fountains, and domestic purposes, and raising melted metals in foundries, so constructed that it cannot lose water, draw grit, draw air, or freeze

1263. J. Kaye, Beeston, near Leeds—Improvements in machinery or apparatus for slubbing, roving, spinning, and doubling wool and other fibrous materials

1264. W. Aldritt, Belfast—Improvements in lighting and ventilating

1265. M. Scott, Great George-street, Westminster—Improvements in roofing or covering reservoirs or holders for liquids

1266. J. Leadbetter, W. Wight, and T. Davis, Halifax—Improvements in machinery or apparatus for raising water and other fluids

1267. J. Skertchly, jun., Kingsland—Improvements in the manufacture of gates, hurdles, and fencing; in vehicles, wagons, carts, and trucks, for common roads and railways; and in facias, entablatures, window-headings, parapet, and other mouldings projecting from the brickwork of buildings

1268. P. Journet, Rue de Belzunce, Paris—Improvements in chucks for lathes

1269. B. Blackburn, Clapham-common—Improvements in the manufacture of pipes when applying slate for such purposes

1270. T. Richardson, Portland-place, Newcastle-upon-Tyne — Improvements in the manufacture of alum

*Dated June 9.*

1271. J. B. M. Erard, Paris—Improvements in the preparation of paint

1272. F. Marguritte, Paris—Improvements in wet gas-meters

1273. R. A. Brooman, Fleet-street—Improvements in machinery for cutting brads, lath-nails, and others of similar character. (A communication)

1274. T. Bramwell, Enfield House, Durham—Improvements in the manufacture of the carbonates and prussiates of potash and soda

1275. J. Nelson and D. Boyd, Selby, York—Improvements in preparing and scutching flax, hemp, and other substances

1276. J. L. Hancock, Neath, Glamorgan—Improvement in cutting, hay, straw, and other fibrous articles and substances

1277. J. Currie and R. Young, Glasgow—Improvements in the treatment and grinding of grain, and the products thereof

1278. B. Cook, Birmingham—Improved means of ornamenting metallic bedsteads, chairs, and couches, which said improvement is also applicable for ornamenting standards for glass frames, tables, and fire-screens, cornice-poles, and other articles of furniture

1280. G. A. Buchholz, Hammersmith—Improved machinery applicable to the hulling or cleaning of grain, seeds, and other vegetable produce

*Dated June 10.*

1282. A. L. Dawson, Southwark—Improvements in machinery for cutting and shaping wood

1283. A. Barclay and J. Barclay, Kilmarnock—Improvements in printing textile fabrics and other surfaces

1284. L. Bois, Paris—Improvements in looms

1285. J. Whitehead, Preston—Machine for weaving wire-netting of iron, brass, or other material. (A communication)

1286. E. P. Alexander, Lincoln's-inn—Improvements in moulding. (A communication from M. De Louvrie, St. Marc, France)

1287. F. Puls, Whitechapel-road—Improvements in electro-galvanic apparatus for medical purposes; parts of which improvements are also applicable to other electro-galvanic apparatus

*Dated June 12.*

1288. J. Young, Wolverhampton—Improvements in locks and latches
1289. R. A. Brooman, Fleet-street—Method of producing plans in relievo. (A communication)
1290. R. A. Brooman, Fleet-street—Improvement in or addition to sugar-basins. (A communication)

*Dated June 13.*

1291. A. L. Péter, Lyons, France—Improvements in treating a certain kind of indigo
1292. C. H. Compton, Bloomsbury—Improved railway-break
1293. W. Southall, Swan-lane—Improvements in machinery or apparatus for cultivating and pulverising land

*Dated June 14.*

1294. J. Barlow, Accrington, Lancaster—Improvements in the mode or method of extracting gluten, and preparing the same for sizing purposes
1295. J. Pickup, Liverpool—Improvements in steering apparatus
1296. J. Hargrove, Kirkstall—Improved machinery for washing, scouring, and felting or fulling

*Dated June 15.*

1297. J. Edwards, Camberwell—Improved knife-cleaner
1298. F. Martini, Mumford-court, Milk-street — Improvement in working steam-engines
1299. T. Wilson and J. Hadley, Birmingham—New or improved method of constructing certain kinds of rolls or cylinders and dies or surfaces
1300. J. Kite, Princes-street, Lambeth—Improvements in machinery and apparatus for expressing moisture from substances
1301. J. Gedge, Wellington-street South—Improvements in the construction of locks and latches, spindles and knobs, applicable to doors and other similar purposes
1302. S. Varley, Stamford, Lincoln—Improved construction of haymaking-machine
1303. J. D. M. Stirling, Blackgrange, Scotland—Improvements in the manufacture of iron. (Partly a communication from M. L. Talabot)

*Dated June 16.*

1304. J. E. Piper, New-road, St. Pancras—Improvements in the preparation of linen, cotton, and other fabrics, to produce a factitious leather
1305. W. Brindley, Moorgate-street—Improvements in applying steam for offensive and defensive purposes
1306. R. Hornsby, Grantham, Lincoln—Improvements in portable thrashing-machines
1307. T. M. Fell, King William-street, and W. Cooke, Curzon-street, Hanover-square—Improvements in ventilators
1308. W. Cooke, Curzon-street, Hanover-square—Improvements in boots and shoes
1309. C. Hargrove, Birmingham—Improvement or improvements in the manufacture of certain kinds of iron
1310. W. Evans, St. Leonard's-terrace, Chelsea—Improved tap for drawing off liquids
1311. F. Martini, Mumford-court, Milk-street — New or improved construction of steam-engines
1312. J. Macnee, jun., Glasgow—Improvements in caps, hats, and other coverings for the head
1313. F. J. Julyan, Gerrard-street, Soho-square—Improved method of producing musical sounds
1314. W. G. Pidduck, Camberwell—Improvements in the construction of vent-pegs
1315. H. Hughes, Aldersgate-street—Improved machinery for cutting and embossing, either separately or simultaneously
1316. T. Parramore, Castle-street, Southwark—Improvement in the manufacture of air-tight seats, beds, and other articles required to be inflated and air-tight
1317. D. Lowe, Leicester—Improvements in knitting machinery

*Dated June 17.*

1318. G. J. Hinde, Wolverhampton, Stafford—New or improved combination of materials to be used for the manufacture of pipes or tubes for drains, or such purposes as the same is or may be applicable to
1319. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in treating bitumen. (A communication)
1320. J. Aspinall, Tavistock-square—Improved means of creating a vacuum or partial vacuum for evaporative purposes
1321. J. Foudrinier, Sherborne-street, Islington — Improvements in machinery for washing, boiling, cleaning, and bleaching rags, fibrous, and textile substances
1322. A. V. Newton, Chancery-lane—Improvements in machinery for block-printing. (A communication)
1323. J. Rawe, jun., Haverstock-hill—Improvements applicable to stoves, stove-grates, or fireplaces for domestic use
1324. G. Holloway, Stroud, Gloucester—Improvements in sewing and embroidering machines
1325. J. A. Williams, Baydon, Wilts—Improvements in machinery or apparatus for ploughing and cultivating land
1326. A. E. L. Bellford, Castle-street, Holborn—Improvements in water-mill machinery (A communication)

*Dated June 19.*

1327. L. A. Henry, Metz, France—Improvements in constructing railroads
1329. Sir J. C. Anderson, Fermoy, Cork—Economical railway for the conveyance of passengers, goods, and letters
1330. G. Mears, Whitechapel-road—Improvements in machinery or apparatus for obtaining sounds
1331. J. Westlake, Newton Abbott, Devon—Improvements in treating the pulverised solution obtained from machines used for crushing ores, gossans, earths, and rocks
1332. J. V. Weber, Orchard-street, St. Luke's—Improvements applicable to chronometers and other mechanism requiring a steady spring power
1333. W. Baur, Munich, Bavaria—Improvements in propelling vessels
1334. P. G. Dartiguenave, Regent-street—Improvements in aërial navigation
1335. J W. Schlesinger, London-wall—Means of readily discovering any street, road, river, locality, or place, on maps, charts, and plans. (A communication)
1336. S. Riley, Oldham, Lancaster—Improvements in pocket-books, bill-cases, or other such depositories
1337. J. Oliver, Wapping—Improved construction of signal lantern
1338. D. Bogue, Fleet-street—Improved apparatus for facilitating the attachment of adhesive stamps. (A communication)

*Dated June 20.*

1339. H. Worrall, Staley-bridge, Chester—Improvements in machinery or apparatus for carding cotton, wool, or other fibrous materials
1340. W. Brunton, Camborne, Cornwall—Improvements in metallic pistons
1341. J. Acland, Langley-cottage, South Lambeth—Improvements in the manufacture of paper
1342. T. L. Holt, Warwick-square, and W. C. Forster, Hatton-garden—Making paper
1343. C. Reeves, Birmingham, and W. Wells, Sutton Coldfield, Warwick—A new or improved method of manufacturing certain kinds of metallic tubes
1344. J. Day, Birmingham—Improvement or improvements in certain kinds of candle-sticks
1345. A. Stephen and A. Pernie, Kelvinaugh, Glasgow—Improvements in the application of materials for and in the arrangement of and method of applying apparatus to be used as templates for ascertaining and marking the proper positions for the rivet and bolt-holes required in the plates, frames, and other pieces or portions of the materials used in the construction or manufacture of iron ships or vessels, boilers, tanks, masts, spars, and other similar articles
1346. J. E. Jesson, Paris—Improved barometer, called "Hydrographer Barometer"
1347. N. Clayton and J. Shuttleworth, Lincoln—Improvements in portable and fixed combined, thrashing, shaking, and winnowing machines
1348. W. T. Monzani, St. James's-terrace, Bermondsey—Improvement in brushes and brooms
1350. F. Braithwaite, Gower-street, Bedford-square—Improvements in constructing suspension-bridges, roofs, and coverings
1351. G. R. Chittenden, Wood-street—Improvements in sewing-machines. (A communication)
1352. A. McLaine, jun., Belfast—Improved mode of constructing and fitting gun-boats
1353. W. E. Newton, Chancery-lane—Improved manufacture of pigments or colouring matters. (A communication)
1354. G. H. Byerley, Brompton—Improvements in machinery for the manufacture of bricks, tiles, quarries, tubes, and other such like articles

*Dated June 21.*

1355. W. Donald and W. Heginbotham, Carlisle, Cumberland — Improvements in looms
1356. J. McInnis, Liverpool—Improved composition for coating the bottoms of iron ships to prevent their fouling, and other useful purposes
1357. H. V. Physick, North-bank, Regent's-park—Electric telegraphs, and apparatus connected therewith
1359. O. R. Chase, Cornhill—Improvements in machinery for manufacturing lozenges, and for other purposes
1360. J. W. Shaw, Birmingham—Improvements in apparatus or machinery for producing motive power. (A communication from Don M. M. J. T. Miciano y-Contillo, Cadiz, Spain)
1361. W. E. Newton, Chancery-lane—Improvements in apparatus for generating and utilising steam. (A communication)
1362. T. Rhoads, Vine-street, America-square—Improved method of framing school-slates. (A communication)
1363. W. Stableford, Worcester—Improvements in railway-breaks
1364. W. Parsons, Paradise-street, Lambeth—Improvements in rotatory engines
1365. J. F. Heather, Woolwich—Improvements in apparatus for regulating the flow of gas

*Dated June 22.*

1366. W. Stidolph, Wintoun-place, Greenwich—Transferable book-marker
1367. T. C. Yates, Bolton-le-Moors, Lancaster—Improvements in wickets for the game of cricket
1368. G. Simpson, Union-buildings, Leather-lane—Improvements in furnaces
1369. J. M. Blashfield, Millwall, Poplar—Improvements in the manufacture of china, pottery, bricks, and other articles manufactured for the most part of clay
1370. W. H. Brown, Sheffield—Improvements in the construction of furnaces for the melting of steel and other metals requiring a crucible in the melting thereof
1371. C. Cowper, Southampton-buildings—Improvements in machinery for combing cotton, wool, flax, tow, silk waste, and other fibrous substances. (A communication)
1372. A. E. L. Bellford, Castle-street, Holborn—Improvements in machinery for forging or hammering iron, which may be also applicable to the hammering of other materials. (A communication)
1373. E. Smith, Carlisle-street—Improved watch-key
1374. A. E. L. Bellford, Castle-street, Holborn—Improvements in grate-bars and certain appliances to the same, for the purpose of preventing them from warping or twisting by heat. (A communication)
1375. G. F. Logan, Glasgow—Improvement in portable winches
1376. A. P. Price, Margate—Improvements in the treatment of certain alloys of tin
1377. A. P. Price, Margate—Improvements in the purification of tin, and in obtaining useful products arising from such purification
1378. G. Ermen, Manchester—Improvements in machinery or apparatus for winding yarns or threads
1379. I. Farrell, Dublin—Improvements in fireproof flooring and roofing, which improvements are also applicable to the construction of walls and bridges, and other like structures

*Dated June 23.*

1380. C. Phillips, Offchurch, Warwick—Improvement of apparatus or machinery for reaping
1381. D. C. Knab, Rue Rosini, Paris—Improvements in the production of carburets of hydrogen
1382. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in machinery for the manufacture of nails. (A communication)
1383. A. E. L. Bellford, Castle-street, Holborn—Improvement in propelling vessels in water. (A communication)
1384. S. Dreyfus-Werth and P. Meunier, Sainte Marie-aux-mines (Haut Rhin), France—New or improved system of applying designs to all kinds of fabrics, and of surfaces of wood, marble, and stone
1385. A. E. L. Bellford, Castle-street, Holborn — Improvements in machinery for picking or opening cotton and other fibrous materials, and all kind of waste rags and old materials, to prepare the same for the operation of carding, or for other operations. (A communication)
1386. T. Rudd, Pimlico—Improvements in stands for casks or barrels
1387. J. Weild, Glasgow—Improvements in preventing the drainage waste of cargoes on ship-board
1388. J. Keyse, Apollo-buildings, Walworth—Improved method of loading muskets, rifles, carbines, pistols, and all descriptions of small arms with cartridge, without applying the cartridge to the mouth
1389. T. L. Dimsdale, Hadley—Improvement in the manufacture of gas for lighting and heating purposes
1390. W. E. Osborn, Milton, New York—Improvements in breech-loading guns or cannon
1391. R. Garrett, jun., Leiston Works, near Saxmundham, Suffolk—Improved arrangement of valves for working steam expansively
1392. R. M. Letchford, Whitechapel—Match-stand and holder for holding matches while being ignited

*Dated June 24.*

1393. H. Lightbown, Pendleton, Lancaster—Improvements in drying pulp in the manufacture of paper, also paperhangings and printed textile fabrics
1394. T. Skelton, Plaistow, Essex—Improvement in or addition to tillers or yokes
1395. R. A. Brooman, Fleet-street—New or improved projectile for ordnance and small arms, and a sabot or plug to be employed therewith, which sabot or plug may also be used with other projectiles. (A communication from W. A. Holwell, Quebec)
1396. D. L. Williams, Cannon-street, and J. W. Neale, Stepney—Improvements in furnaces
1397. R. A. Brooman, Fleet-street—Improved mill for grinding and pulverising paints and various vegetable and mineral substances. (A communication)
1398. J. Davies, Bristol—Improvements in propelling vessels
1399. J. Thomson, Newton-le-Willows, Lancashire—Improvements in centrifugal apparatus used in the manufacture of sugar
1400. J. Kenworthy and T. Rigby, Preston, Lancaster—Improvements in waterclosets

1401. R. Bottomley, Rochdale, D. Schofield, Oldham, and H. Spencer, Rochdale, Lancaster—Improvements in machinery or apparatus for spinning and doubling cotton and other fibrous materials
1402. J. Revell, Newark, Nottingham—Improvements in horse-shoes

*Dated June 26.*

1403. E. Hubner, Mulhouse, France—Improvements in machinery for preparing wool, cotton, silk-waste, tow, and other fibrous materials
1404. A. Bain, Queen's-row, Camberwell—Improvements in fire-arms and the apparatus connected therewith
1406. J. Brown, Haddington, Scotland—Improvements in the manufacture of metal spouts or troughs
1407. W. Palmer, Sutton-street, Clerkenwell—Improvements in candle-lamps
1408. C. Beale and J. Latchmore, Leicester—Improvements in the manufacture of knitted shirts
1409. T. H. Bakewell, Wellford-road, Leicester—Improvements in the manufacture of gloves
1410. W. Yates, Mary-street Bromley—Improvements in furnaces

*Dated June 27.*

1411. W. Brindley, Moorgate-street—Improvements in the construction of life-boats
1412. A. Smith, Princes-street—Improvements in the manufacture of certain kinds or descriptions of wire and other ropes and strands
1413. C. H. Collette, Lincoln's-Inn-fields—Improvements in the manufacture of beer. (A communication)
1415. R. L. Antrobus, Birmingham—New or improved method of printing oil-cloth for floor and table covers, paperhangings, and other surfaces
1416. W. Morgan, Birmingham—Improvements in machines for cutting paper, card, and millboards, woollens, veneers, and materials used in making paper; parts of which improvements are applicable to other machines where quick and slow motions are used, and where machinery is required to be thrown into and out of gear
1417. C. Iles, Birmingham—Improvements in metal bedsteads
1418. W. Coltman, High-street, Leicester—Improvement in knitting-frames
1419. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in apparatus for producing aerated waters. (A communication)

*Dated June 28.*

1420. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in the construction of axle-boxes. (A communication)
1421. J. Brunlees, Manchester—Improvements in drawbridges applicable to rail and other roadways
1422. H. S. Edwards, Cranbourne-street—Improvements in preparing textile fabrics or materials, for the purpose of their better retaining colours applied to them. (A communication)
1423. E. Cockshutt, Preston, Lancaster—Improvements in bungs or adjustable stopper apparatus for casks and other vessels
1424. J. Morison, Paisley, Renfrew—Improvements in the treatment or manufacture of ornamental fabrics
1425. T. Schlœsing, Paris—Improvements in the manufacture of carbonates of soda
1426. J. G. Jones, Roscommon-street, Liverpool — Improvements in apparatus for teaching addition

*Dated June 29.*

1427. W. J. Biesecker, Birmingham—New or improved method of labelling bottles and such other vessels or articles as require or may require labelling
1428. C. S. Sperry, Connecticut, U. S.—Improved knitting-machine. (A communication from W. M. Chase, Boston, U. S.)
1429. T. Markland, Hyde, Chester—Improvements in machinery or apparatus for warping, dressing, and weaving textile materials
1430. W. Smith and W. B. Hayes, Manchester—Improvements in power-looms for weaving

*Dated June 30.*

1431. E. J. Hughes, Manchester—Improvements in sewing-machines. (A communication)
1432. J. Edwards, Manchester—Improvements in railway-chairs
1433. D. Shears, Bankside, Southwark—Improvements in curing or separating moisture from sugar and other substances. (A communication)
1434. L. F. Izart, France—New mode of removing organic vegetable substances from woollen fabrics
1435. W. T. Monzani, St. James's-terrace, Bermondsey—Improvements in the manufacture of folding chairs, stools and other articles to sit or recline upon
1436. N. Thompson, jun., New York—Improvements in regulating the supply of steam from steam-boilers
1437. H. G. Gray, Commercial Wharf, Mile-end-road—Improvements in preserving potatoes, roots, plants, grain, and seeds
1439. T. Slater, Somers-place West, St. Pancras, and J. Tall, Crawford-street, Marylebone—Improvements in the construction of planes, and in cutting-apparatus, and in the machinery employed therein
1440. J. H. Johnson, Lincoln's-inn-fields—Improvements in machinery or apparatus for winding thread or yarns. (A communication from L. J. N. Carpentier)

*Dated July 1.*

1441. R. L. Jones, Chester—Improvements in locks and keys
1442. J. Hulme, Manchester—Improvements in steam-engines, and in valves; parts of which improvements are applicable for diminishing friction in other engines
1444. J. H. Johnson, Lincoln's-inn-fields—Improvements in submarine navigation. (A communication from Messrs. Payerne and Lamiral)
1445. J. H. Johnson, Lincoln's-inn-fields—Improvements in stoppers for bottles and other vessels, and in apparatus connected therewith. (A communication from H. Bordet)
1446. G. Hutchison, Glasgow—Improvement or improvements in the manufacture of soap
1447. J. Wilder, Reading,—Improvements in agricultural rollers and clod-crushers

*Dated July 3.*

1448. J. K. Milne, Edinburgh—Improved means of holding letters, documents, or other similar articles
1449. B. Walters, Wolverhampton—Improvements in spindles for locks and latches, and in the means of adjusting knobs to the same, to suit any thickness of door
1450. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in stopping bottles, and in drawing off aerated or other liquids contained therein. (A communication)
1451. W. Greenshields, Edinburgh—Improvements in chenille fabrics
1452. W. Balk, Ipswich—Improved friction dynamometer
1453. A. V. Newton, Chancery-lane—Improvement in the construction and arrangement of marine steam-engines. (A communication)
1454. J. Hopkinson, jun., Huddersfield—Improvements in steam-boilers and furnaces, and in apparatus connected therewith
1455. E. A. D. Guichard, Paris—Improvements in ornamenting the surfaces of various articles and fabrics
1456. U. Chauveau and C. d'Epinois, Paris—Improved means or apparatus for preventing collisions on railways

*Dated July 4.*

1457. J. Sunter, Derby—New or improved drilling-machinery
1459. C. T. Tiffany, Leeds—Improvement in the manufacture of brushes used in gig-mills and machinery for brushing piled fabrics
1460. T. Haimes, Melbourne, near Derby—Improvements in the manufacture of gloves and mits by warp machinery
1461. J. McGaffin, Liverpool—Improvements in corrugated cast-iron
1462. J. A. C. N. Delpech, Castres, France—Improved lift and force pump, called "Castraise Pump"
1463. J. Newman, Birmingham—Improvements in the manufacture of metallic rods, rails, and bars
1464. J. M. Bardet and F. Collette, Paris—Improvement in the construction of matches
1465. R. Garrett and R. Garrett, jun., Leiston Works, near Saxmundham, Suffolk—Improvements in machinery for drilling seed and manure
1466. G. D. Bishopp, Inverness-terrace—Improvements in the construction and arrangement of engines to be driven by steam, air, gas, or water
1467. T. Elliott, Manchester—Improvements in safety-valves, and apparatus connected therewith, which valves may also be used as steam-valves
1468. H. Heycock, Manchester—Improvements in hydraulic presses employed for packing or pressing cotton, silk, flax, wool, or other fibrous materials
1469. D. Bowlas, Reddish, Lancaster—Improvements in machinery or apparatus for knitting or manufacturing healds or harness used in looms for weaving
1470. J. H. Johnson, Lincoln's-inn-fields—Improvements in obtaining motive power. (A communication from J. E. Armengaud, Paris)
1471. J. H. Johnson, Lincoln's-inn-fields—Improved system or mode of coating iron with copper. (A communication from E. Bocquet, Corbehem, France)

*Dated July 5.*

1472. L. J. Cheval, Raismes, France—Improvements in beer-engines
1473. J. Burch, Crag-hall, near Macclesfield—Improvements in marine and other steam-engines
1475. T. Restell, Strand—Apparatus or holder for holding parcels of gloves and other goods and papers
1476. W. Symes, Pimlico—Improvement in tills

*Dated July 6.*

1480. J. Glasgow, Manchester—Improvements in machinery or apparatus for cutting, compressing, punching, shearing, and shaping metals
1482. O. Avery, Castle-street—Improvements in sewing and stitching-machines
1484. J. Lamb, Newcastle-under-Lyne — Improvements applicable to machines for cutting paper
1486. J. Radcliffe, Stockport—Improvements in power-looms for weaving
1488. J. H. Johnson, Lincoln's-inn-fields—Improvements in electro-magnetic engines. (A communication from T. C. Avery, New York)
1492. J. Petrie, jun., Rochdale, Lancaster—Improvements in machinery or apparatus for washing or scouring wool

## PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

1414. S. Shipley, Stoke Newington—Improvements in fittings, suitable for dressing-cases, and for other purposes of elegance and utility.—June 27.
1458. A. S. Stocker, Hall-street, City-road—Improvements appertaining to match-boxes, and in the fitting, stoppering, and covering of tubes and other vessels of glass, porcelain, and other materials.—July 4.
1513. P. F. Aerts, Brussels—Improvements in constructing parts of railway rolling-stock, and in the lubrication thereof.—July 11
1515. T. Henley, Brompton—Improvements in the preparation of certain colouring materials.—July 11
1520. W. Eassie, Gloucester—Improvements in trucks used on railways.—July 12.

### NOTICES OF APPLICATION FOR LEAVE TO ENTER DISCLAIMERS.

A petition has been presented to the Attorney-General for leave to enter a disclaimer or memorandum of alteration of the specification of the invention for which letters patent were granted to Charles Hancock, gentleman, on the 29th day of July 1848, bearing the title, "Improvements in apparatus and machinery for giving shape and configuration to plastic substances." The parts of the specification which the petitioner desires to disclaim are from the word "firstly" to the word "fourthly," from the word "lastly" to the word "harden" (with the drawings there referred to) and the first, second, third, and sixth claims.

A petition has also been presented by William Seed, of Preston, Lancashire, machine-maker, for leave to disclaim a portion of the specification of his patent for "Certain Improvements in machinery or apparatus for preparing, slubbing, and roving cotton and other fibrous substances," dated July 14, 1846.

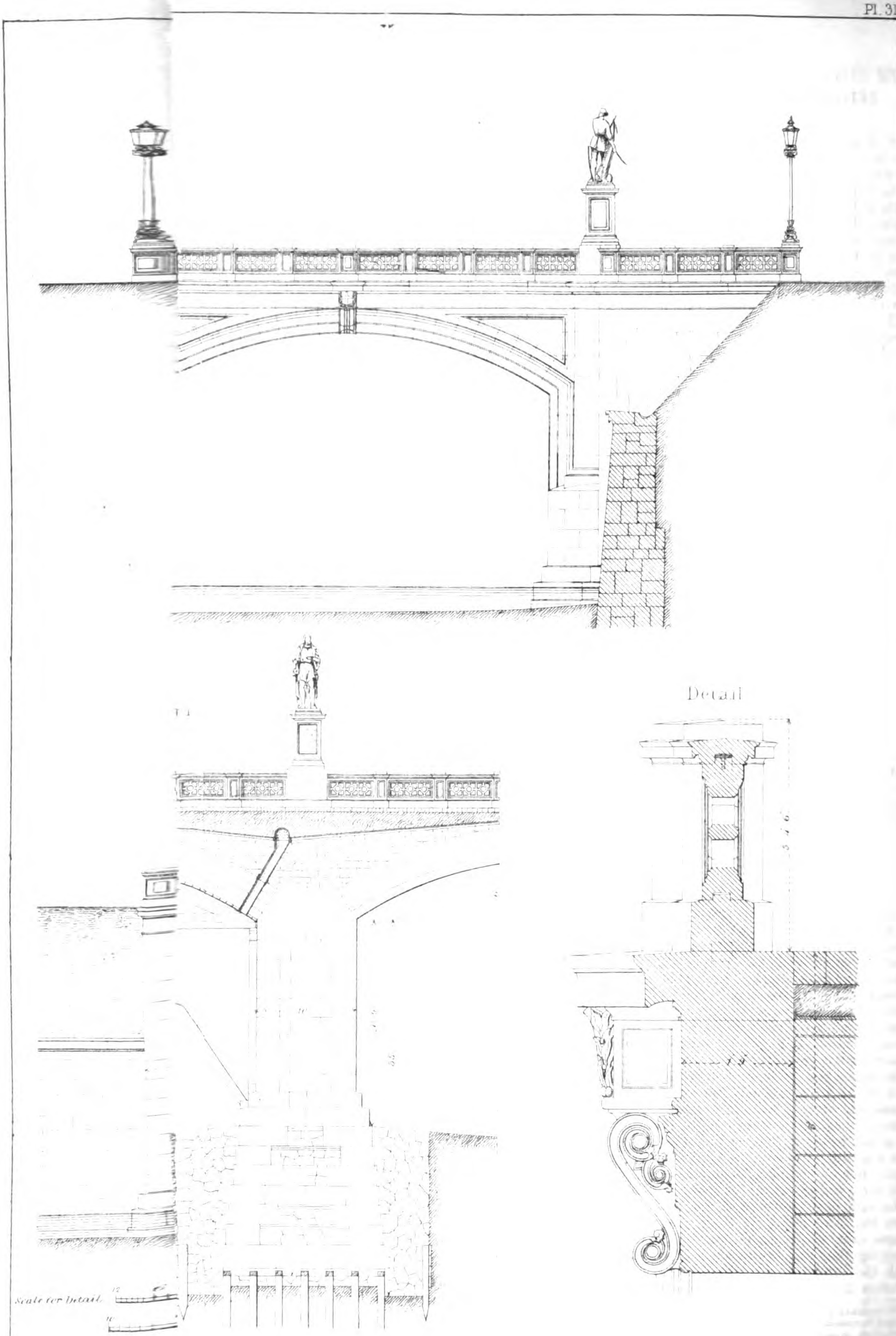
A petition has been presented to the Attorney-General for leave to disclaim a portion of and amend the title and specification of letters patent granted to Peter Fairbairn, of Leeds, Yorkshire, machine-maker, for "Improvements in machinery for heckling, carding, drawing, roving, and spinning flax, hemp, tow, silk, and other fibrous substances." Dated October 26, 1848.

### NOTICES OF APPLICATION FOR PROLONGATION OF PATENTS.

A petition will be presented to her Majesty in Council by Edward Foard, late of Queen's Head-lane, Islington, in the county of Middlesex, now of 39, Nicholas-street, Hoxton, in the said county, machinist, praying her Majesty to grant a prolongation of the several letters patents granted to him for England, dated 16th January 1841; for Scotland, dated 16th July 1841; and for Ireland, dated 28th August 1841; for "An improved method or improved methods of supplying fuel to the fireplaces or grates of steam-engine boilers, brewers' coppers, and other furnaces, as well also to the fireplaces employed in domestic purposes, and generally to the supplying of fuel to furnaces or fireplaces in such manner as to consume the smoke generally produced in such furnaces or fireplaces." On the 14th August (or on the next day of sitting of the Judicial Committee of her Majesty's Privy Council, if it do not sit on the day mentioned) an application will be made to that Committee to fix an early day for the hearing of the matters contained in the said petition; and any person desirous of being heard in opposition, must enter a caveat to that effect in the Privy Council Office on or before that date

A petition will also be presented by Edward Godson, of Aldersgate-street, in the City of London, ironmonger, as assignee of the above-mentioned several letters patent granted to Edward Foard, for a prolongation of their several terms; and on the 16th of August (or on the next day of sitting of the Judicial Committee of her Majesty's Privy Council, if it do not sit on the day mentioned), an application will be made to that Committee to fix an early day for the hearing of the matters contained in the said petition; and any person desirous of being heard in opposition, must enter a caveat to that effect in the Privy Council Office on or before that date.

A petition will be presented to Her Majesty in Council by Mary Honiball, of St John's-Wood, widow, praying her Majesty to confirm the letters patent granted to her on the 9th February, 1853, for "Improvements in Anchors," or to grant new letters patent for the same invention, for which William Henry Porter, of Russia-row, Milk-street, Cheapside, in the City of London, warehouseman, obtained letters patent on the 15th August, 1838. An application will be made on the 29th August next to the Judicial Committee of the Privy Council (or so soon after as their lordships shall be sitting) to fix a day for hearing the matters contained in the said petition; and all persons desirous of being heard in opposition, must enter a caveat to that effect in the Privy Council Office on or before that date.

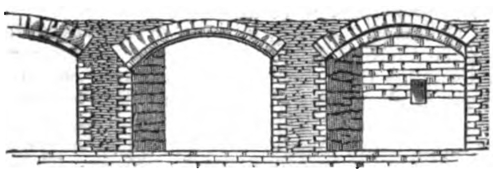


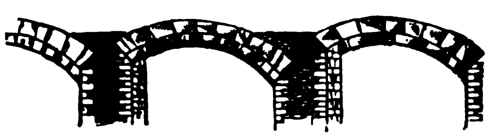

J. R. Jobbins

## THE OLD AND NEW BRIDGES OVER THE WIEN, BEFORE THE KÄRTHNER-GATE, VIENNA.

(*With an Engraving, Plate* XXXI.)

M. Förster, the able conductor of the *Allgemeine Bauzeitung*, has been appointed by the municipal authorities of Vienna to construct the new bridge over the Wien, one of great importance to the traffic of the Austrian capital. The above-named journal contains the following particulars relating to the subject. It appears that the old bridge was already standing in the 13th century, and, on its being demolished, M. Niernsee, the engineer, thus speaks of it. Amongst the most curious features are the oblique arches, which were constructed of square blocks, between which rubble and masonry formed the complement. As this, however, would not have been sufficiently strong for the heavy traffic, an arch of bricks, one foot thick, was added on the part towards the flow of water. The piers consisted of an irregular dressing of square blocks, and rested on a bed of concrete, fat lime, river sand, and large and small rubble, 6 feet in thickness, which was laid on oak piles irregularly placed. From the indications shown, it would appear marvellous that the bridge had not long since crumbled to pieces.





The old bridge was closed for traffic in September 1850, but when the floods of the spring of 1851 had carried away another bridge then building, the question was raised, whether the plan of M. Förster should be abandoned altogether. Still, the new building was begun in the summer of 1851, the precaution being adopted of making the foundations 5 feet deeper than originally proposed, since which time the new Vienna bridge has advanced favourably towards its completion.

## PROPOSED ADDITIONAL CATHEDRALS.*

The subject which has occasioned the pamphlet before us is one which, from various causes, has of late attracted much public attention. With an ever-growing population, the serious responsibility of its rulers is of no little moment, and the need of providing and maintaining ample as well as suitable means to supply its religious wants, becomes imperative. It is the especial distinction of this nation, that every one is free to perform his sacred duties in the way his conscience best approves; but, with this toleration to all, it is wisely understood that *one* form shall be exclusively recognised by the law of the land.

The origin and history of cathedral churches is a matter on which so little is generally known, that it may be acceptable to our readers, while it will form an appropriate introduction to the question immediately before us, to string together such information as can be gleaned, so as to present a comprehensive idea of what was contemplated and what has been accomplished by their establishment. Historic documents on the subject are comparatively rare, and therefore the more valuable and instructive.

The cathedral churches of England and Wales which existed before the Conquest, had their origin in the early missionary colleges, each consisting of a bishop, with his associated clergy (living together and maintained by common funds), by means of which the inhabitants of this country were converted to the Christian faith.

* 'Additional Cathedrals: a Letter, written at the request of a Member of the Cathedral Commission, on the question of what existing Churches would be available as Cathedrals, in case of the erection of Additional Sees.' By George Gilbert Scott, Architect. London: J. H. Parker. 1854.

The four bishoprics in Wales claim the highest antiquity, they having been founded chiefly in the earlier part of the sixth century, and belonging to the ancient British Church. The churches in England coeval with these were ruined by foreign invasions and some of them refounded by the Roman missionaries in the time of the Saxon heptarchy. There were then no parochial ministers; the bishop and his clergy resided at the cathedral church, where public worship was maintained, the word of God preached, and schools of Christian education established. Many of the English bishops received their education in the "*Monasteria*," places of retirement wherein persons might be brought up in a way of devotion and learning, to fit them for further service. Yet, antecedent to the Conquest, it would appear (*Dugdale:* Canterbury, York, &c.), that, as a result of these labours, a parochial clergy had been organised, each ministering in his own church, with a definite cure of souls.

In the next period, dating from the Conquest, we find the cathedral institutions assuming a form required by the altered circumstances of the Church. The dioceses were divided into parishes, having each its own minister and a separate endowment, the whole being under a still more marked administration. Besides the bishop, there was a dean, a precentor, a chancellor, and a treasurer; with archdeacons, canons, prebends, and a chapter council.

While the organisation above described was introduced into the nine English cathedral churches known by the title of the Old Foundation (viz., York, St. Paul's, Chichester, Exeter, Hereford, Lichfield, Lincoln, Salisbury, and Wells), the substitution of monks for the secular clergy was effected in three other cathedrals, Canterbury (1080), Durham (1083), and Rochester (1089), as had previously occurred at Winchester and Worcester.

During this period the stately fabrics of the cathedrals which now exist, and the greater part of our parochial churches, were built.

The collegiate church of Manchester was founded, in 1422, for a warden and eight fellows; and the royal chapel of Windsor, in 1483, consisting of a dean and twelve canons.

It may be observed here, that, by the Regulations of the Province of Canterbury, the bishops are considered as forming a cathedral chapter, of which the primate is the bishop; the Bishop of London, dean; the Bishop of Salisbury, precentor; the Bishop of Lincoln, chancellor; and the Bishop of Winchester, sub-dean.

About the time of the Reformation, many alterations inevitably took place. There had previously existed thirteen cathedral churches of the Old Foundation, the nine in England already specified, four in Wales (St. Asaph, Bangor, Llandaff, St. David's), and eight conventual churches attached to bishoprics (Winchester, Worcester, Canterbury, Durham, Rochester, Norwich, Ely, and Carlisle). The changes alluded to as now occurring were not so much materially affecting the constitution of those bodies, as modifications to suit the doctrine and ritual of the Reformed Church of England.

In the era we are now discussing, Henry VIII. founded five new bishoprics, associating with each a dean, and chapter of canons,—viz., Bristol, Chester, Gloucester, Oxford, and Peterborough, endowed wholly or in part out of the possessions of the respective monasteries in those places.

To the subsequent changes which have taken place it will be needless to make more than a general allusion, as they are chiefly on points of subdivision and discipline, although in their working the aspect of affairs took many phases. The statute of Henry VIII., having been framed before the Reformation was completely carried into effect, and in some cases not having been promulgated with due form and authority, it was found necessary to grant amended statutes to several of the collegiate churches, and this was done by royal authority, by virtue of the power reserved to the crown. The laws of patronage have also been re-adjusted.

The present state of the several cathedrals, with reference to the operation of the above acts, shows as follows. It appears that there are in the

| | |
|---|---|
| Patronage of the Crown ........................ | 27 gifts |
| „ of the Lord Chancellor ......... | 12 „ |
| „ of the Bishops ..................... | 90 „ |
| „ of the Universities or Colleges | 5 „ |

The whole number of Deaneries is thirty; of residentiary canonries, according to the provisions of 3 & 4 Vict. c. 113, one hundred and thirty-four. The whole number of clergy in England and Wales is about 18,000.

We must not, however, forget Ripon, and Manchester; which, from *collegiate* churches, are now made *cathedrals*, and annexed to newly-founded bishoprics.

*Collegiate Churches.*—A few words may be added regarding these, and exhibiting the distinction between them and cathedrals. The cathedral contains the *cathedra*, *sedes*, or *see* of the bishop; and the city in which the cathedral is situate gives a name to the diocese in which it is placed. A collegiate church has no such character; but, to speak strictly, has a *collegium* or capitular corporation, and in some cases a collegiate institution, for the purposes of education, attached to it. In some instances, also, the collegiate church is exempt from episcopal jurisdiction, a condition of things originally introduced under the Papacy, but which has been consideraby modified since the Reformation, and particularly in recent times.

The following churches in England and Wales are commonly called *collegiate*, though some of them have now lost that character, and have been made *parochial*:—

| | |
|---|---|
| Westminster. | Wolverhampton. |
| Windsor. | Southwell. |
| Middleham. | Brecon. |

Statistics give thus much respecting the ecclesiastical history of bishoprics; we will now subjoin a short statement of what has been done and is doing in the maintenance and repairs of some of the fabrics themselves, as collected from the answers of the several chapters on this branch of inquiry.

Two-thirds of the cathedral and collegiate fabrics are represented as being in sound and good repair as regards safety; though in many cases it is stated, that owing to the perishable nature of the stone and other causes, the ornamental parts of the exterior are much decayed, and that a large outlay is continually required. But a few churches are described as being in a bad state, especially Carlisle, on which, as a special case, the Ecclesiastical Commissioners have agreed to expend forthwith 15,000*l.* In several cathedrals very extensive restorations and improvements, substantial and decorative, have been carried out, partly by means of capitular funds and contributions from individual members of chapter, and partly by the aid of public subscriptions.

At Canterbury the amount expended in thirty years is estimated at nearly 100,000*l*; a gradual restoration of the whole fabric, outside and in, having been in progress from 1823 to the present time. The north-west or Lanfranc's Tower was rebuilt at a cost of 25,000*l.* At York, the restorations consequent on the two calamitous fires of 1829 and 1840, have been effected at a cost of 106,500*l*; of which 71,590*l.* was derived from public subscription. An additional sum of 5000*l.* has been laid out on the chapter-house and the peal of bells. Hereford has been in process of restoration since 1841, and is still far from complete, although nearly 30,000*l.* has been expended on it. At Ely, the beautiful south-west transept has been rescued from a state of desecration, thoroughly repaired, and opened to the church; the ruined chapel adjoining it has been rebuilt from the ground on its original plan; the eastern portion of the church restored to its former beauty; and a new choir formed. The outlay has been about 17,000*l*; and, with donations for special works, the funds contributed swell to a total of about 30,000*l.*, inclusive of the late Bishop Sparke's gift of 15,000*l.* for the east window of the choir. At Wells, also, the choir has been restored, and other works executed, at a cost of nearly 13,000*l.* The Cathedral at Llandaff, having suffered great injury in 1722, was partially rebuilt in a style quite at variance with its original character. In the year 1844 this was resumed on a more correct system, which is still in progress, the expense of which has amounted to 6275*l.*, of which about two-thirds was derived by public subscriptions.

In several other cases smaller restorations have been carried out, which partake of the general spirit of improvement which has prevailed during the present century.

There are not more than a *third* of the cathedrals which have any fabric fund, and most of such belong to the Old Foundation; often among these the fund is very small! Where there is no special fabric fund, the repairs are provided for out of the general capitular revenues; in most cases by the setting aside of certain portions of income derivable from woods, reserved rents, &c., with additions from the general funds in cases of emergency.

The total amount expended on the twenty-eight cathedrals and the two churches of Westminster and Windsor, during the last fourteen years, has been about 370,000*l.*, derived as follows:—

| | |
|---|---|
| From chapter funds and individual contribution of members | £250,000 |
| From public subscriptions | 120,000 |

When it is remembered that for many years previous to those to which the above calculations refer, large sums had been annually devoted frequently to the same object, it may be anticipated that the future requirements, for substantial works at least, will for a time be diminishing.

It is matter for congratulation that so large an amount has been available to the purpose within so comparatively short a period, and for still greater satisfaction that it has been expended in an age when the respect due to the founders of noble edifices had been observed, and the conservative rather than the destructive principle had been cherished. The Vandalisms committed during the last century under the name of repair or restoration are irretrievable. Certain it is, that while for very much of this may be pleaded unwitting ignorance, still more must be imputed to wilful caprice. Sir Christopher Wren has the credit of setting an example in his avowed dislike to Gothic architecture, and his consequently clothing it in classic detail when compelled to employ—we can hardly say imitate—it. Yet even he is too often misjudged. It is with architecture as with other things; that for which we have earliest conceived a predilection, or which chance has thrown in our way when shaping our education, will ever retain its influence; and devotedness to any particular study, or to the various developments of that study, is sure to engender feelings and prejudices, which can be strengthened, but can with difficulty be effaced. A story in point, though almost incredible, is told of the celebrated Brindley, the canal engineer, who when twitted about his favourite hobby, and asked what he thought was the use of rivers, is said to have replied, in sober earnestness,—*to feed canals!* This affords some palliation for the grievous errors which the said Sir Christopher has committed in Westminster Abbey, especially in its west front. There are few who demur to the propriety of the two towers, and it is evident they were originally contemplated; nor do many find fault with the grouping or outline, when seen from a distance; this seems to indicate that the architect had studied as usual the general effect of his composition, but, for want of that thorough knowledge which long and careful examination of good models is alone capable of imparting, he has lamentably failed in the "making-up" of his parts. This, we say, was a case of unwitting ignorance, as proved by his own words in writing to the Bshop of Rochester, on the subject of these very works: "I shall," says he, "speedily prepare proper draughts and models, such as I conceive proper to agree with the original scheme of the architect, without any modern mixtures to show my own inventions." But, in speaking of Wren and the Abbey, it may be well to remark that the modernisings of this building must be laid to the door of others besides our great architect. What does a pompous marble against the south wall of the adjoining cloister record? It is to the memory "Edvardi Tufnell, architecti, qui latera hujusce augustissimæ ædis Australe et Orientale magnâ ex parte refecit et exornavit; et inde sibi * * * perennius extruxit monumentum. Obiit 2° Septembris A.D. 1719." We are not aware that writers on the history of the Abbey have ever noticed this account, which, thanks to the *filii* who originally *posuerunt* the tablet, and to the authorities who have lately made clearer its hieroglyphics, is thus plainly set forth, as if to win the admiring gaze of the passer-by.

The disfigurements our cathedrals sustained during the first half of the past century we may charitably characterise as short-comings; in the second and more disastrous half, as sheer, wanton conceits. One scarce can bear to read of the wholesale destructions which then were rife; of some of which architects were the perpetrators, and others in which the so-called conservators of the respective edifices were either principals or knowingly connived. To allude to the freaks in which but one individual was permitted to indulge at three of these noble structures. James Wyatt,—"transcendantly distinguished in his profession," as his memorial slab at Westminster, one could almost think derisively, tells us—at Salisbury swept away the old altar screen; also the Beauchamp and Hungerford Chapels (whose discordant fragments were jumbled together to compose a new organ screen); and in the process destroyed numberless tombs, thus altering the whole internal plan; and then, by way of finish, he "white-washed" the walls (as probably he did himself too, in true Pecksniffian style); and hastened to make himself equally famous at Lichfield. There, after repeating the same dose, he was guilty of the enormity of blocking, or fairly building up the arches between the choir and the aisles, making a sort of chancel 200 feet in length, without side openings to give it breadth or relief. Another scene of his exploits is Durham; and here, by paring and scraping alone, he is said have removed full 1100 tons weight of stone. He took down the parvise over the north porch, substituting a tricky pediment. He actually purposed clearing away the noble galilee, because it stood in the way of a convenient carriage-drive contemplated between the castle and the west door of the cathedral! This was in 1796, and the dean, Lord Cornwallis, coming down for his "summer residence," found its destruction already commenced, but was in time to save it; posting to town, we are informed, to protest his ignorance of what had been going forward, although the very person most responsible, as he should be most interested, for the condition of the building.

We mention these instances in self-gratulation that better times have since dawned. Ignorance and inattention are no longer venial; deans and chapters are not quite such snug bodies as they were, nor can architects let loose their vagaries with impunity. There is little now that escapes the ordeal of public criticism, and this has a tendency to put or preserve things on their right footing. Church disputes are of course subjects on which we do not touch: but who, while he laments the ill-savoured truths which are too often brought to light, can doubt that inquiries such as have been instituted at Rochester, Guildford, St. Cross, Dulwich, and Stoke Pogis, will tend in the issue greatly to strengthen the efficiency and maintain the purity of the Establishment? Revelations like those we just hinted at have had their share in provoking the legislature to active operations, and to the appointment of committees and convocations to take the whole question of ecclesiastical affairs into deliberate consideration. Among these commissions is one by Royal authority in 1852, deputing certain bishops, clergy, and their legal functionaries, with two noblemen (in all numbering twenty), to inquire into the state and condition of the several cathedral and collegiate churches in England and Wales, "with a view," (among other things,) "to the suggestion of such measures as may make the said cathedral and collegiate churches, and the revenues thereof, available in aid of the erection of new sees, or of other arrangements for the discharge of episcopal duties." From what has transpired of their proceedings, we may judge that they are strongly in favour of the proposed alterations. They state that many places once were sees which are now deprived. Thus, at the Reformation twenty new ones were to be erected: and, among these Westminster, which was elected to a bishopric, but only lasted nine years. Again, sees have not unfrequently been transferred from one city to another, and Bishop Godwin, in his catalogue of bishops, enumerates fifty-two places in the two provinces of Canterbury and York, which at different times were episcopal sees. Coventry was once a bishopric by itself, but an agreement was subsequently made between this city and Lichfield that they should choose their bishops alternately, and make one chapter: so that the Bishop of Coventry was styled Bishop of Coventry and Lichfield, which title was preserved till the time of the Dissolution. This order was afterwards reversed, and "Lichfield and Coventry" is the designation familiar to most of our ears; yet, recently, by a strange perverseness, it has been stripped wholly of the privilege, and annexed to the diocese of Worcester.

In 1852 the bishops and clergy of the province of Canterbury, assembled in convocation, observed in their address, that "although the population of England and Wales has been doubled in the last half-century, the number of English and Welsh bishops remains nearly the same as it was three centuries ago."

Now, to meet these exigencies, it has been thought advisable to scan the several districts of England, so as to ascertain with tolerable correctness the population of each, with the provision for their religious wants, and to note in the survey such localities as either have historical claims or other recommendations to become the centres of new spheres; and it is in connection with this inquiry that the little work which has called forth this article, was originated. "Intended only as a private communication in reply to individual inquiries," as the preface states, "it has been suggested that it might be convenient that the reply should be printed;" and, though it is presented in the humble form of "A Letter," there is a mine of information comprised which cannot fail to be of deep historical and archæological interest. Perhaps there is no person better acquainted with the architectural remains in our land, especially its ecclesiastical resources, and their bearing on the subject in question, than the author of this pamphlet. He discusses the facilities as well as requirements of each county, *seriatim*, in a way that shows him well qualified to give an opinion; and if only as a text reference for architects, the mass of careful information is surprising. The uniformly practical nature of the treatise fits it more for study than extract, but we may be permitted to transcribe the author's recapitulation of districts which have struck him as appearing the best suited to form new dioceses, with the towns and churches which in such case would appear suited to become their episcopal seats:—

| | |
|---|---|
| "1. Northumberland | Hexham. A very noble church |
| 2. Westmoreland and Furness | Kendal or Cartmel. Good churches; the latter an ancient priory church |
| 3. Part of the North Riding of Yorkshire | Qy. Whitby? Ruined abbey |
| 4. The East Riding | Beverley with Hull. The minster at Beverley perfect, and a noble church at Hull |
| 5. Part of West Riding | Qy. Leeds? Using Kirkstall Abbey |
| 6. Western Lancashire | Liverpool. No cathedral |
| 7. Qy. Derbyshire? | Derby. No cathedral |
| 8. Nottinghamshire | Southwell. Minster perfect |
| 9. Shropshire | Shrewsbury. Nave of abbey church |
| 10. Qy. Leicestershire? | Qy. Leicester? Perhaps St. Margaret's. (No church really suitable) |
| 11. Warwickshire | Coventry. St. Michael's |
| 12. Hertfordshire | St. Alban's. The abbey church |
| 13. Essex | Colchester. (No cathedral) |
| 14. Qy. Part of Middlesex? | Qy. Westminster? The abbey church |
| 15. Berkshire | Qy. Windsor or Reading? |
| 16. Cornwall | Bodmin or St. German's |
| 17. Dorsetshire | Sherborne. The minster |
| 18. Somersetshire | Bath. The abbey |
| 19. Surrey | Southwark. St. Saviour's |
| 20. Suffolk | Bury St. Edmund's. St. Mary's |
| 21. Wales, counties of Brecknock and Radnor | Brecon. The priory church |
| 22. The Channel Islands | St. Peter's, Guernsey, or St. Helier's Jersey. (The latter I believe not a good church)." |

Prefixed is a reference map of England and Wales, in counties, showing also the extent of the several dioceses, which are clearly defined by the different tints. It needs but a glance at this interesting sheet to be convinced of the imperfectness of the present arrangements, and the consequent urgency of some such changes as are under consideration, and which must doubtless be set on foot ere long.

## THE NEW TOWN HALL, BURSLEM.

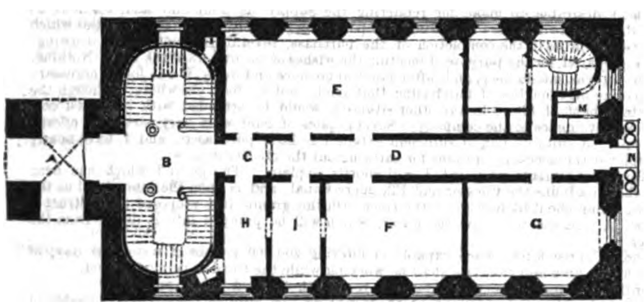
THAT the present age is essentially one of progress and improvement, is a remark which is corroborated by the events of our daily history. We continually hear of the edifices and institutions of byegone times being swept away and superseded by others of more modern date, and more in accordance with the spirit of the age. This progressive movement is everywhere observable, from the great metropolis itself to smaller and less distinguished localities. In few places, perhaps, has the march of improvement been more defined and remarkable than in the Potteries during the last few years, the aspect of the district having been greatly changed for the better in that period by the erection of beautiful churches and chapels, public institutions, extensive manufactories, handsome shops and houses, and other edifices. The town of Burslem, which has been not inaptly styled "the parent of the Potteries," has not been behind-hand in these respects with its younger offspring; and it is at length succeeding in effecting an object which has long been contemplated, and which has become necessary to meet the requirements of the increasing importance and population of the neighbourhood—namely, the erection of a more commodious Town Hall.

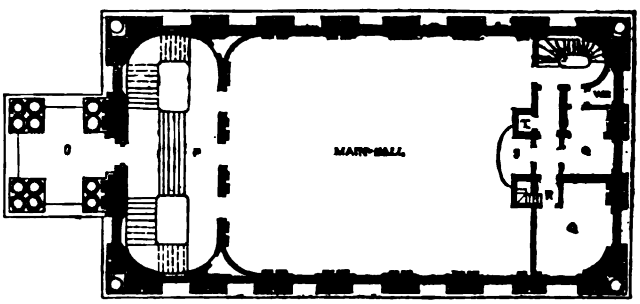
The demolition of the old building was determined on some months ago, and that determination having been carried into effect a short time since, active measures were taken to replace it without delay with an edifice more worthy of the town; and on the 24th May the laying of the corner stone was celebrated by a grand procession, composed of several thousands of persons, and extending fully a mile and a half, and afterwards by a public dinner.

The form of the ground being an irregular triangle, necessarily limits the size of any regular rectangular figure placed within it, and for this reason, the architect, though at first inclined to adopt an irregular figure for the plan of the building has, on mature consideration, chosen a regular parallelogram, as being more simple in arrangement, and producing an elevation of more grandeur and boldness of effect than could be obtained by a broken and irregular outline.

In fixing the dimensions and site of the building, due regard has been had to the thoroughfare and traffic in the different streets; that on the south side will be 60 feet wide, the same width as it now is; the street on the north side will be 30 feet wide at the narrowest part, and a clear space of 50 to 60 feet will be left between the Town Hall and the Market Hall; and the building being thus completely isolated, will have an importance and nobleness of aspect suitable to its purpose.

PLAN OF GROUND FLOOR.




PLAN OF PRINCIPAL FLOOR.

In the basement there is to be a room for the warming apparatus, a coal-store, a kitchen provided with a lift to a room on the principal floor, a pantry, a store-room and cellar, with a rolling way from the street. All the rooms in the basement will be well lighted by windows into an open area on the north side.

We now come to the ground floor, the figure of which, as we stated, and as shown in the annexed plans, is a regular parallelogram, 109 feet long, 58 feet wide outside the walls. At the west end there will be a projecting porch A, sufficiently wide to admit carriages to pass through, so that the occupants may alight protected from the weather. From this porch a large doorway will open to the entrance hall B, from which two handsome staircases will lead to the main hall on the principal floor.

At the east end there will be another entrance N, by a wide and airy corridor to the several rooms, the first of which on the left is intended for the news-room G, containing an area of about 560 superficial feet; adjoining the news-room will be a board-room F, of 600 feet area; with two retiring rooms H, I, connected therewith, which may be used as offices. On the north side of the corridor is the magistrates'-room E, extending nearly the whole length of the building, and containing an area of about 900 feet. The magistrates'-room will serve for lectures and other purposes, for which the main-hall would be too large. The bench for the magistrates is to be placed at the east end of the room, and communicate with the corridor and the retiring rooms adjoining, on the north side of the corridor; and nearer the entrance will be the passage leading to the hallkeeper's residence, and also private stairs to the orchestra, the stairs to the basement, watercloset, and lavatory. The height of the rooms on this floor will be 15 feet.

The principal floor will be mainly occupied by the great hall, which will contain a floor area of 3350 feet, exclusive of the orchestra or platform S, at the east end, occupying a space of 800 feet. The two staircases before mentioned are to be united into one spacious and imposing flight of steps, leading at their point of junction to a large open portico O, from whence popular assemblages in the open air may be addressed, and which will be sufficiently spacious to accomodate the speakers and a considerable number of their supporters. From this point in the stairs, five steps P, 16 feet long, lead to three large doors by which access is gained to, or egress from, the principal hall.

A private staircase R, will lead to the orchestra, forming a private entrance for performers, and also for the principal speakers and others at times of public meetings in the hall. Under the orchestra or platform there will be a number of private rooms in one of which will be the lift or hoist T, from the basement, by which all the viands, dishes, &c., required at the time of a public dinner may be sent up direct from the kitchen to the hall, without delay of risk or chill, and avoiding the confusion of running up and down stairs by the attendants.

At the back of the orchestra there will be another small staircase, by which chorus-singers and others at the rear may retire without crowding upon those in front. These stairs will also lead upwards into the roof for access to the clock chamber, and also to the valves for ventilation.

The architect has chosen the style usually called the Cinque-cento-Italian, or that employed by Michael Angelo, Raffaele, Palladio, and others in Italy, in the 15th and 16th centuries, and afterwards in our own country by Inigo Jones and Sir Christopher Wren. He has been induced to employ this style, not more from their example than from its complete applicability to the purpose, and in which a greater amount of light can be admitted and more architectural decoration obtained at the least expense of space and money. It will also better harmonise with the architecture of the adjoining Market Hall.

The principal features of the elevation will consist of a bold, rusticated, battering basement, relieved by large windows, the jambs and arches of which are to be deeply coved. Surmounting this will be a double-pilastered façade of the Corinthian order. In the intercolumniations will be wide, arched windows, with moulded archivolts.

The roof will be covered with Italian tiles of the local manufacture, producing a pleasing effect from an essentially structural feature.

The west elevation will have for its principal feature the entrance porch, surmounted by the portico before mentioned. Over this is the clock chamber, and the clock and bell turret, with four faces sufficiently elevated to be seen from all parts of the surrounding neighbourhood.

The east elevation is the same as three bays of the south side, having in the centre the doorway leading to the rooms on the ground-floor, and decorated with a suitable portico.

The north elevation will be the same as the south.

With respect to the architectural decorations of the great hall, we may mention that the interior will be similar in character to the exterior, consisting of a pilastraded wall, with a coved and panelled cornice and deeply-trabeated ceiling. We understand that in arranging the dimensions and proportions of the hall, due attention has been paid to acoustic effect therein; and though the proportions may appear wanting in height, this has been purposely done to aid the effect of sound, both vocal and instrumental, and to prevent the great reverberation and echo invariably heard in lofty and apparently well-proportioned rooms.

The building is intended to be heated by a hot-water apparatus, fixed in the basement, and pipes carried through each of the rooms, and has been undertaken by Mr. Whitehead, of Preston.

The architect is G. T. Robinson, Esq., of Leamington, and formerly of Wolverhampton; and the builder is Mr. Young, of Burslem. Mr. R. Hales, Surveyor to the Local Board of Health, as town surveyor, is carrying out the design, under the architect.

## CHESTER WATERWORKS.

A controversy of some interest is going on in Chester, relative to the water supply of that ancient city. The present waterworks, which have been established about twenty-six years, have supplied the town very inefficiently for a long time past, pumping the water, with an old ricketty engine, directly from the river into the cisterns of the consumers, without filtration, and distributing even that very partially on the intermittent system of supply.

In the autumn of last year, the Corporation determined that the public of Chester should no longer be subjected to the sanitary evil of an impure and inefficient water supply, and they gave notice of their intention to go to Parliament for a new bill to supply the town with pure filtered water, and on the system of constant supply under high pressure.

Accordingly, Messrs Rammell and Lester were instructed to lay down a scheme of water supply for the town, and they proposed taking it from the neighbourhood of Delamere Forest (which district Mr. Bateman, in a letter to Lord Shaftesbury, stated was capable of supplying even Liverpool). The estimated cost of this scheme was 32,000*l.*

The Waterworks Company, finding the Corporation were determined to proceed with their bill, came forward and pledged themselves to the town, at a public meeting, that they would so improve and extend their works that there should be a constant supply of water under high-pressure, ample in quantity, and that it should be properly filtered; which pledge the Corporation was disposed to receive, and the Wat works Company instructed Mr. Bateman to prepare such a plan of water supply that would carry out the suggestions of the Company and the general wishes of the town.

The proposed plans of Mr. Bateman are as follows:—There are to be three pumping-engines, two at the side of the River Dee, and one under the service tank, which is about 300 yards from the river. There is to be *one* subsiding reservoir to hold 400,000 gallons, into which the water will be pumped from the river; from thence it is to be passed through filters, of which there are to be three, of the following dimensions: two 63 feet by 50 ft. 8 in., and one 40 feet by 50 ft. 8 in., area 8576 feet, which are stated to be capable of filtering and purifying 960,000 gallons daily.

From the filter it will flow into a pure-water tank of 400,000 gallons capacity, and from thence the water is to be pumped into an elevated service-tank on a tower 60 feet high above the ground. The tank is to be 70 feet diameter and 14 feet deep through the centre of the tank; the engine-chimney will be carried 158 feet above the surface of the ground.

These several works are shadowed forth in the report of Mr. Bateman, which we have annexed; but it appears that the Corporation and the Company are at issue (see Borough Engineer's report, also annexed) as to whether the plans proposed will afford a constant supply under high pressure, *in the full acceptation of that term*; and whether, from the very impure character of the Dee water after heavy rains, it will be pure at all times, and fit for human consumption;—whether the mains of the Company, which have been laid down now some twenty-six years, very close to the surface of the streets, very much broken and patched, some of which are wood and lead, are suitable for a high-pressure supply;—and also, whether the fire-plugs, which are upon the old spigot-and-faucet principle, should be retained (the liability of the repairs of which the Water Company repudiate!), while the wants of the town demand hydrants of an improved construction. It is also argued that the quantity of pure water these works are capable of supplying is insufficient, there being only *one* store reservoir, capable of holding only 400,000 gallons for 30,000 inhabitants—two-thirds of a day's supply! Surely the gentleman who is to give so copious a supply to Manchester (45,000,000 million gallons for 316,213 inhabitants, with reservoirs amounting to 344A. 0R. 39P., and capable of holding 507,906,831 cubic feet), will not, in these days of sanitary reform, deal out on the other hand such a stinted measure of water supply for an increasing population like Chester. We now give the reports as they have reached us, without further comment, and express a hope, which is generally felt throughout the country, that in devising schemes for the future water supply of towns, that supply may be copious and cheap, so that the humblest cottager may realise the full benefit of an ample quantity, at a low rate, of that necessary of life.

[Copy.]

TO THE CHAIRMAN AND DIRECTORS OF THE CHESTER WATERWORKS.

You wish me to state the various steps which have been taken for the purpose of improving the supply of water to the city.

In the spring of 1849 I had first the honour of receiving your instructions to take the supply of water into consideration, and to advise you as to the best course to be pursued, with a view to its proper and perfect filtration.

After examining various situations closely adjoining or continuous to your pumping establishment, on which filters might be constructed, and that there existed considerable difficulty in obtaining a suitable site, I recommended you to sink into the red sandstone rock, which forms the bed of the River Dee, to a sufficient depth by the side of the river to enable you to pass under it, as near to the bottom of the river as could be done with safety, in the hope that the water of the river would pass through the rock into the tunnel in a perfectly filtered state, and in a sufficient quantity to meet the demands of the city.

The best situation for filters appears to be on the opposite side of the river; and it was a recommendation in favour of the scheme of tunnelling proposed, that should we be disappointed in obtaining a supply of filtered soft water by percolation from the river, the tunnel would afford a communication by means of which the water of the river, after having been artificially filtered on the opposite side, could be conducted to the pumps of the company, and forced from thence into the town for use. In case of success, it was intended to tunnel or chamber under the bed of the river to such extent as might be found necessary for obtaining the requisite supply. The water of the River Dee was analysed, and was found to be exceedingly good and very soft. The only objection to its use without filtration being the occasional turbidness caused by heavy rains and floods. The water issuing in springs from the red stone, and found in the course of sinking the shaft alluded to, was bright and beautiful to look at, and pleasant to drink; but *very* hard, and consequently unfit for general domestic use. This is the common characteristic of water from the new red sandstone formation.

The operations recommended were commenced in the course of the summer or autumn of 1849, and extended over a considerable period. They were, however, comparatively unproductive of good water, and after some time it was deemed advisable to abandon them. The tunnel had been driven to the opposite bank of the river, and negotiations were entered into for the purchase of the requisite land for the construction of filters. This land *was supposed to have been purchased* now twelve months ago; and I then received instructions for laying out the necessary works, not only for the perfect filtration of the water, but for such other improvements in the supply as it might be deemed desirable to make for rendering the supply as abundant and efficient as possible. Drawings were accordingly prepared, and in consequence of difficulties which afterwards arose in the completion of the purchase, several different sets of drawings were prepared, for the purpose of meeting the wishes of the owners of the land. Nothing, however, was satisfactory, and, after much annoyance and delay, it was found necessary to give up all thoughts of purchasing that land, and to look elsewhere; although the establishment of filters in any other situation would be attended with increased cost and inconvenience to the company. Several plots of land were suggested and offered for sale. A suitable plot of sufficient extent has been purchased, and I have nearly completed the necessary designs for carrying out the objects in view.

The arrangements proposed I will shortly explain. The ground which has been purchased adjoins the Chester and Ellesmere Canal, and is upon the same level as the canal, being about 65 feet above the river. On this ground it is proposed to construct—

1st. A reservoir to receive the water, which will be pumped into it direct from the river.

2ndly. Three filters, each capable of filtering 300,000 gallons of water per day, of which it is proposed that two shall be working while the third is being cleansed.

3rdly. A covered reservoir or tank, to receive the filtered water; and

4thly. An elevated tank, about 65 feet above the level of the ground, capable of holding about 200,000 gallons, into which the filtered water will be pumped, and from which the city will be supplied *constantly*, and at a pressure sufficient to allow the water to rise freely to the highest floor of the highest house in the city.

It is also proposed to put down additional pumping engines; to lay down new mains to the city, and to extend and enlarge the piping generally.

The contract drawings are nearly ready, and the works may be completed in about six or eight months after being commenced: probably, if great exertion be made, in a somewhat shorter period. When finished, the city will be supplied in as perfect a manner as possible, and with water of most excellent quality.

Your very obedient servant,

*Manchester, November 19th* 1853. J. F. BATEMAN.

N.B. The costs of these works are estimated at 12,000*l.*

[Copy.]

WATER SUPPLY COMMITTEE.

The following report was read:—

The deputy town clerk having laid before the committee certain plans of the works proposed to be carried out by the Waterworks Company, and the following report of the surveyor having been read:—

"*Chester, August* 7, 1854.

"Gentlemen—The drawings you have submitted to me are further detailed plans of the proposed improvements of the Chester Waterworks; but these, in my opinion, will not supply your committee with the necessary information that you may pronounce an opinion upon them; they are mere details of parts of the works. What your committee require are full and comprehensive plans of the whole works, showing where and how the supply of water is going to be obtained; the nature and power of the machinery intended to be used; the means and extent of storage; the system of purification and mode of supply; and the plan to be adopted in distributing the water, whether for domestic use or for other purposes.

"This is necessary preliminary information that must, I presume, be in possession of the Waterworks Company previous to the commencement of works that are to cost, they say, 12,000*l.*

"In the absence of that information, I may observe, on the information I possess, it is well known that the present source of supply of water to the city is very impure, being immediately below the point where the drainage of the eastern part of the town discharges itself into the River Dee. Surely it is intended to remedy this evil by taking the water at a higher and purer source.

"Again, it is stated that the Company intend to give a constant supply of water under high pressure; if that is the case, it is necessary that the pumping engines should be in duplicate at both pumping stations, viz., by the river side and in the Spital Field, *as is usual in all modern waterworks*; instead of that, I understand they intend erecting only two new engines, so they will have two at the river side and one in the Spital Field. In case of accident to the engine in the Spital Field, the supply of water must cease (with the exception of the small quantity in the service tank) until that accident is repaired.

"I think, also, the subsiding reservoir too small for a population like Chester; its contents, according to the plans, are to be 400,000 gallons, or less than one day's supply. (Chester requires 600,000 gallons, according to the usual calculation, on the number of the population, as a daily supply) so that for the supply to be continuous the water must be pumped daily, whatever may be the state of the river; and this I think objectionable, as it is well known that the river water after heavy rains is filthy and discoloured for days together, and which no process of subsidence or filtration will purify under two or three days. This, I understand, is the experience derived at the Eaton Waterworks (where Mr. Simpson was the engineer). Under these circumstances there should be two storage reservoirs, which should contain at least two million gallons, one million gallons in each reservoir; so that while one was supplying the town, the water in the other might be subsiding and depositing its muddy sediment after the reservoir was filled. I presume it is also intended to relay and amend the distributing pipes in the town, which are generally in a defective state, as well as introduce improved hydrants. Neither the pipes nor the hydrants (which latter are upon the worst possible principle of construction) will withstand the hydraulic head of the proposed high pressure supply of water; and to attempt to introduce the high pressure supply until those defects are remedied, appears to me to be a very impolitic step, if not an impossibility.

I am, &c.

"The Water Supply Committee." B. BAYLIS, C.E., A.I.C.E.

"*Resolved*—That the drawings which have been submitted to the committee do not afford sufficient information to enable the committee to understand the exact nature and extent of the works intended to be constructed, but from the details which have been supplied, it is evident that they will be incapable of insuring such a continuous supply of pure water as the city requires, and as was promised when the guarantee of the company was given to the council in December last.

"That the plans are not only imperfect, but the Company has not afforded any information as to the pecuniary means at their command for carrying them into effect.

"That the required extension of the mains to various parts of the city and suburbs is not stated; and that no allusion is made to the prices which it is intended to charge the public, but that the committee infer from certain published notices of the Company that a considerable increase in the rates is contemplated; that the present objectionable source from whence the supply is taken appears to be retained, and that the delay which has taken place in proceeding to fulfil the pledges given to the council and the public last year is unreasonable and censurable.

"The committee, therefore, in discharge of the duty intrusted to them, cannot recommend the council to give their sanction to the plans which have been submitted; and express their dissatisfaction that at a time when the committee was led to expect an improved supply of water, nothing effectual has been done to remedy the present unsatisfactory state of the works.

## SUPPLY OF WATER TO THE METROPOLIS.

*An Abstract Return of the average number of gallons of water supplied daily by each of the several Metropolitan Water Companies, during the twelve months ending the 31st day of December 1853, and stating whether the supply can be increased, or is in course of being increased; and a statement of the number of houses, manufactories, and public establishments supplied with water by each Company.*—[By order of the House of Commons, June 1, 1854.]

*New River.*

The average number of gallons of water supplied daily by the New River Company in the year 1853 was 17,537,396, and this quantity is capable of being increased to 29,000,000.

The houses, manufactories, and public establishments were as under: viz. Houses, 90,510; Manufactories, 223; Public Establishments, 191; Total, 90,924.

FREDERICK INGLIS,
*June* 16, 1854. *Clerk.*

*East London Waterworks.*

The average quantity of water supplied daily by the company, during twelve months ending 31st December 1853, was 11,990,989 gallons.

The number of dwelling-houses supplied by the company during 1853 was 63,142.

The number of manufactories and public establishments supplied by the company during 1853 was 463.

This supply, which is capable of increase to any extent proportionate to the requirements of the district, is in course of increase accordingly.

J. CECIL,
*June* 15, 1854. *Secretary.*

*West Middlesex Waterworks.*

The average quantity of water supplied daily by the West Middlesex Waterworks, for seven days in the week, during the twelve months ending the 31st December 1853, was 5,000,606 gallons.

An additional main, 30 inches diameter, has recently been laid from the works at Hammersmith into London; which is enlarged to a 36-inch main from Bayswater to the company's reservoir at Barrow Hill, adjoining Primrose Hill. Also another powerful engine is now being erected at their pumping establishment at Hammersmith; by which means this company will be enabled to increase their supply of water by about 6,000,000 gallons per diem.

The number of houses supplied by this company (exclusive of stables) is 24,376.

The number of manufactories, comprising also breweries, dye-houses, steam-saw mills, &c., is 28.

The number of public establishments, comprising hospitals, workhouses, baths and wash-houses, theatres, barracks, bazaars, botanic gardens, markets, &c., is 23.

The above enumeration of manufactories and public establishments does not, however, include several other trade supplies, such as livery stables, omnibus establishments, cow-yards, nursery grounds, &c., or charity-schools, almshouses, dispensaries, &c.

W. H. WHIFFIN,
*June* 20, 1854. *Secretary.*

*Grand Junction Waterworks.*

The average quantity of water actually pumped daily for six days in each week, from the 1st of January to the 31st of December 1853, amounted to 5,968,288 imperial gallons, equivalent to a daily supply delivered for each of the 365 days during the year, of 5,115,675 imperial gallons.

The number of houses, manufactories, and public establishments supplied with water to the same period, amounts to 16,019. Upon the completion of the company's new works, they will have the power of very largely increasing their supply, as the engines at Hampton and the trunk main will be capable of delivering above 20,000,000 imperial gallons per diem.

Since the period to which the above return has reference, the number of houses supplied, and the average daily quantity of water delivered, have considerably increased. For the twelve months ending the 1st of April last, the water delivered daily for seven days in the week, amounted to 5,518,343 imperial gallons, and the number of houses, &c., supplied, to 16,417.

E. O. COX.
*June* 1854. *Assistant Secretary.*

*Southwark and Vauxhall Water Company.*

Quantity of water supplied by the company, from the 1st January 1853 to the 31st December 1853.

| | |
|---|---|
| | Gallons. |
| Total quantity pumped in the year ...................... | 2,652,573,277 |
| Being an average per week of ........................... | 51,011,024 |
| Or an average per day (for six days in the week)...... | 8,501,837 |
| 40,046 Houses supplied, averaging per day, 175 galls. | 7,001,837 gallons. |
| 634 Consumers, namely, railways, distilleries, road-watering, fires, flushing sewers, and trades generally, averaging per day 2366 gallons.......................................... | 1,500,000 gallons. |
| 40,680 tenants, averaging per day 209 gallons ...... | 8,501,837 gallons. |

This supply can be more than doubled if required; the 36-inch main, with the engine-power provided at Hampton, will deliver at Battersea 20,000,000 gallons in the twenty-four hours.

JAMES ROSSITER,
*June* 29, 1854. *Secretary.*

*Lambeth Waterworks.*

The average quantity of water delivered daily by the Lambeth Waterworks Company, in the twelve months ending 31st December 1853, was 5,603,000 gallons per diem.

The supply can be increased from the existing works of this company at Seething Wells to upwards of 10,000,000 gallons per diem, and by the erection of additional works on lands acquired by the company, under the Lambeth Waterworks Act, 1848, the supply of water may be carried to the utmost extent that can ever possibly be required.

The number of houses at present supplied by the company is 25,583, and the manufactories and public establishments 524 in number.

W. S. PHIPPS,
*July* 20, 1854. *Secretary.*

*Chelsea Waterworks.*

The average daily supply of water by the Chelsea Waterworks Company, during the twelve months ending 31st December 1853, was 5,632,000 imperial gallons.

The supply of water can be increased about 15 per cent. from the present works, and new works are in course of construction above Kingston-on-Thames, under the Chelsea Waterworks Act, 1852, which will enable the company to double the quantity, and the supply may be still further augmented when required, the company having possessed themselves of land for the purpose.

The number of houses supplied with water was 22,725, and the number of manufactories and public establishments 2004.

ALBERT GILL,
*July* 21, 1854. *Secretary.*

*Kent Waterworks.*

The total quantity of water delivered during the twelve months ending the 31st day of December 1853, was 671,942,164 gallons.

The average daily supply of six days per week was 2,146,780 gallons.

The foregoing is the year's and average daily supply delivered by the company's engines during 1853; but in estimating the power of supply of a waterworks, it should be taken at the highest day's demand. In the course of last summer this has risen frequently at these works to near 4,000,000 gallons, and could without any inconvenience be increased to any quantity required by the district.

The number of houses in supply on the 31st December 1853 was 14,573.

The number of public establishments and manufactories supplied by this company are as follows:

The supply and constant protection from fire of the Government naval and military establishments at Deptford and Woolwich, and Greenwich Hospital.

The public baths and wash-houses.

Seventeen manufactories, bleachers, gasworks, railways, and steam-engines.

Water was also supplied for flushing sewers, and road and street watering.

W. R. MORRIS,
*June* 14, 1854. *Engineer to the Company.*

*Hampstead Waterworks.*

During the year 1853, the number of houses supplied by the Hampstead Waterworks Company was 5454.

The average daily supply of water was 607,368 gallons; of this quantity about 3000 gallons a day were for manufacturing purposes.

During the six months, from March to October, an additional quantity, averaging 45,000 gallons a day, was supplied for the purpose of watering streets and roads.

There is no public establishment in the district supplied by these works.

For the purpose of increasing and improving their resources, this company are boring through the chalk at their works in Kentish-town, in the expectation of deriving an abundant supply of pure water from the greensand. The depth of the boring is now 940 feet. The work is prosecuted with all possible speed, and the directors have every reason to think it will soon be brought to a successful issue. Meantime arrangements have been made with the New River and West Middlesex Waterworks, and the mains connected, so as to furnish any quantity of water which may be required in the district.

THOMAS HAKEWILL,
*Secretary.*

*June* 16, 1854.

## FORMING SHEETS OR PLATES FROM SLAGS.

GEORGE ROBINSON, *Patentee*, August 27, 1853.

THIS invention consists in the conversion of the molten slag (formed in the various processes of manufacturing, puddling, and refining iron and other metals) into sheets or plates, by pouring it upon an iron or other table artificially heated, whereon it may, by means of rolling or pressing, be reduced to any requisite thickness, according to the purpose for which it is intended to be used. The plates thus formed are afterwards annealed by being allowed to cool gradually in any suitable furnace; and may be employed for roofing and other useful purposes for which they may be considered applicable.

The slags best adapted for the formation of sheets or plates by the processes about to be described, are those of a metallic appearance, and which are more or less crystalline in structure, and contain iron or other metals in various proportions, combined with silica and other earthy substances. They are variously termed, but may be easily recognised by the above description.

These slags or refuse matters are to be used while in a fluid state; that fluidity being derived either from the heat of the furnace in which they are first formed, or from their being afterwards remelted in any convenient manner. In order to form from these refuse matters the sheets or plates required, the molten slag is poured upon an iron or other table, artificially heated, and is pressed or rolled out thereon, by suitable machinery, to any requisite thickness, after the manner used in manufacturing plate-glass, or by any other suitable mechanical arrangements which will readily suggest themselves to any intelligent mechanic. The sheets or plates thus formed are at once to be transferred to a suitable annealing furnace, previously heated, and there allowed to cool gradually for from six to eight days, or even less. When cold, the sheets may be employed for roofing buildings, covering walls, and for many other useful purposes.

The sheets or plates, while in a plastic state, may likewise be cut, perforated, and ornamented by means of suitable elevations and depressions on the rollers by which they are formed. For instance, rough sheets of suitable thickness having been obtained on the table, slabs with mouldings or other ornaments thereon may be produced, by causing dies or engraved or ornamented rollers to press on the upper surface of the sheets, and produce any impression that may be required. These slabs must of course be annealed in the same way as the thin sheets above mentioned.

The patentee remarks that he is aware that slags have heretofore been cast into blocks in moulds, and have been employed for paving and such like purposes; he does not therefore intend to claim the application of blocks cast in moulds, nor does he intend to confine himself to any particular mechanical contrivances for forming the sheets or slabs as above mentioned; but he claims—first, the formation of sheets, plates, or slabs, of various thicknesses, from the slabs or refuse matters obtained during the manufacture of metals, by rolling or otherwise pressing the molten slag on tables artificially heated; and secondly, the application of the sheets, plates, or slabs thus formed to roofing and other useful purposes.

## EDUCATIONAL EXHIBITION.

### *Abstract of Lectures, Papers, and Discussions.**

*On Models and Diagrams.* By THOMAS SOPWITH, F.R.S.

THE lecturer commenced by stating that his present object was to speak of models and diagrams as applicable to ordinary use in schools. Of these, models were, he considered, the more valuable, inasmuch as they are a representation of the solid form of an object, and can be viewed in any direction, whereas a diagram, even in its most pictorial form, only presents one aspect of the object, and if different portions of the same object are required to be shown they are necessarily separated. The portability and cheapness of diagrams as compared with models, renders them better adapted for extensive use in schools, and the disadvantage of presenting only one face of an object becomes a means of instruction, inasmuch as all the practical applications of drawing depend on a right appreciation of the laws under which solid forms can be represented on a plane surface.

The real use of the model is to carry the mind from the actual observation of a small object presented to the eye to the comprehension of a large object, not presented to view; and in doing this, the mind is necessarily employed in a study of relative dimensions, and of corresponding forms. Excellent models of geometrical forms, as the cube, &c., are to be had at a small cost; but in the smallest village school, unprovided with funds for the purchase of expensive models, much may be done at a very small cost; as for example, the construction of a cube may be explained by a piece of pasteboard, and so of the other simple geometrical figures; and the mode of construction is indirectly an explanation of geometrical conditions, as for example, that the tetrahedron is bounded by 4 surfaces—the cube by 6. The gonigraph may be easily made by a country carpenter, or even by a skilful lad, and is well represented by the ordinary scales or rules used in France. It affords a ready model of various geometrical figures.

In astronomy it is desirable that all scholars should learn something of the motions, and magnitudes, and distances of the heavenly bodies. The most rapid motion which can be readily comprehended by boys is about 20 miles an hour, or one mile in three minutes. It is about double the quickest speed they see in road vehicles, and is a usual rate on railways; but it will be brought still nearer to their comprehension within the walls of the school-room, by a white ball fastened to a string of about 3 feet in length, and whirled round at the rate of two revolutions, nearly 40 feet in each second, and by graduating the length of the string, and timing the revolutions to 120 in each minute; the length of a mile may be described by the ball in 3 minutes, and if this were continued an hour we should have 20 miles of space passed over by the ball. When once the minds of children are directed to a palpable illustration of this kind, they have obtained as it were the seeds of knowledge—they have a foundation on which to rest all future researches of a like kind, and without some such solid, distinct, clear, and palpable exhibition of the rate of motion, no definite ideas will be afforded by the most skilful and elaborate study of mere figures unapplied to some such datum. Very few persons have clear conceptions about space and motion. If we ask a child the meaning of a sentence which it has read, we probably find that no solid or distinct ideas of the meaning of the sentence have been formed, and so it is with children of a larger growth. With men, and even with able and accomplished men, propositions involving large conditions of space and motion are read by them, and stated by them as truths, without even attempting to resolve them into tangible considerations. What, for example, is so common as to hear it said of Archimedes, that if he had a fulcrum on which to rest, the power of a lever would enable him to move the world; and so it is taken for granted that by an enormous lever the weight of Archimedes, exerted at the extremity of its enormous arm, would suffice to move the world. In theory this is true, but how few have an idea how far it is from all practical value. If Archimedes had machinery free from friction, and in perfect equilibrium, so that his whole power could be made available, it would require him, at 16 hours a day, and using his whole power, more than *seven millions of years* to move the earth through the *one-hundred millionth part of an inch.*

Mr. Sopwith then proceeded to explain various other kinds of models, which were capable of being simply constructed in paper and cardboard as geological models—models of local districts—models of school-rooms, and others.

He referred to the lectures of Richard Dalton, as an example of the great utility of models, illustrating mechanics, hydraulics, hydrostatics, optics, astronomy; and spoke of several other mechanical models. He considered that collections of models should be made in every large town, and that government should offer premiums for their production.

Under the head of diagrams, the lecturer spoke as to—1, the principles of construction; 2, the objects capable of illustration; 3, the materials to be employed; and 4, the special advantages they afford in promoting education. A diagram being the representation of one or more objects on a plane surface, due regard must be paid to the exhibi-

* From the 'Journal of the Society of Arts.'

tion of it in such a form as to convey a clear idea to the mind. An uninstructed person, who, for the first time, attempts to make a diagram of a cylinder, is disposed to make a circle for the top, and then continue lines to represent the length of the cylinder. Again, an inexperienced draughtsman, wishing to represent the shaft of a mine, with two roads at the top, one running direct north and the other east, and with two drifts, or galleries at the bottom, one going south and the other west, would in the first instance, represent the roads the same as on an ordinary ground plan, with the top of the pit (or hollow cylinder) at the point of intersection. He would proceed to lay down the shaft in a perpendicular line, and the south and west drifts in their relative position to the north and east roads. The fallacy of this figure must be apparent to every person. We perceive, then, that every diagram must be designed in a certain relation to the truth, in order to convey correct ideas to others. The methods of effecting this are,—first, by a ground plan; secondly, by a sectional plan; thirdly, by an isometric projection; and, fourthly, by a parallel projection. If the object to be designed or explained only has relation to one uniform plane surface, then the first of these modes is all that is required; but in every solid object the representation must depend on one or other of these methods of projection, unless perspective delineation is necessary. Diagrams require a close adherence to geometrical accuracy, and, for the most part, are capable of being delineated by projection by parallel rays. The first and second of these modes are especially meant to represent one surface only. When solid forms are to be delineated, we may have recourse to the third method, which is best explained by reference to a cube, with a house and tower upon it. The fourth plan is based on the theory of shadows, by which a principle is afforded for a mode of delineation of great practical value.

Of the objects capable of illustration, Mr. Sopwith first adverted to number, which might be represented by a space of length, and its relation to other numbers by lines of comparative length; thus we had a method of teaching addition, subtraction, multiplication, and division, which ought to be in use in *every* school. The next general application of diagrams is to represent space, in relation to area, for as to mere extension, that is only the repetition of number. In areas we have to deal with a different mode of progression, and the *line* 3 times the length of another, is the index to an *area*, if square, of 9 times. And we may proceed, from the relative size of the school-room, one square mile, one hundred square miles, England, Scotland, and Ireland, Europe, and finally the globe; and so by a series of well-studied diagrams, the mind may be carried from magnitudes easily understood, to those vast distances which can only be comprehended by patient study; but which process is equally required in every department of art and science.

This subject is one which is scarcely at all known in hundreds—nay, in fact, in the great majority of the humbler class of schools. The few examples adduced would serve to show the useful aid which they afford to the teacher, the animation they impart to otherwise dry and uninteresting lessons, the awakening of *new* ideas in the mind, and the formation of correct habits of thought. All these show forth the value of such means of illustration in the school, but *here* their value only begins, for they establish in the eye of the youthful student an exact habit of observation; which will be of the greatest use in every stage of life; whether it be in the recreations of travel, in the pursuit of science, in the following industrial occupation of any kind, however humble, scarcely a day can pass without affording some opportunity of applying the kind of knowledge which has been imparted; in every department, from the complicated details of finance, or other difficult statistical conditions, which claim the mind of the statesman, down to the humblest artisan, well-constructed diagrams may be made the means of presenting, as in were in one field of view, combinations and relations of numbers, value, or space, in relation to time, or other conditions, in a way which cannot be done by means of figures or descriptions.

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*On Teaching Crystallography.* By Rev. Walter Mitchell, M.A.

The lecturer commenced by stating that few geometrical forms had been greater favourites with the ancient geometers, than those regular solids known by the name of the Platonic bodies. It had been stated that Plato and his followers had affirmed that the greatest secrets of nature were contained in them. So far as we are aware of, they were unacquainted with the fact that three out of the five Platonic solids are found in nature, formed by the action of the molecular forces of matter with a precision and accuracy defying the imitation of art. After the prophetic vision of the scientific value of these forms had slumbered for many ages, the genius of Haüy gave the first glimpses of their practical application to a revelation of some of the most recondite mysteries of nature. A natural crystal of chrome alum, in the form of a perfect octahedron, one of the Platonic bodies, whose edges were about an inch in length, was exhibited. The fact that fluor spar occurs frequently in perfect cubes was mentioned, and that this mineral possesses the property of cleaving or splitting readily in such directions as to enable us with great ease to cut out a perfect octahedron from the cube.

By means of models it was shown how a cube of fluor spar afforded a demonstration of the last proposition but one of Euclid's Elements—the 3rd proposition of the 15th Book—"How to inscribe an octahedron in a given cube." The cube of fluor spar would readily split in such directions as to present the form of an octahedron or a tetrahedron, and thus afford accurate models of three out of the five Platonic bodies, while it could not be broken so as to present clean smooth surfaces in any other directions. Many other bodies in nature, of which the diamond was one, possessed the same properties in this respect as fluor spar.

The ready way in which some minerals cleave was illustrated by breaking some portions of calcareous spar, the fragments invariably presenting the edges and inclinations of a geometrical solid known by the name of the obtuse rhomboid, the angles of which were always similar. White marble, reduced to the finest powder, presented under the microscope no rough fragments, but sharp and defined rhomboids.

The accidental discovery of the cleavage of calcareous spar by Haüy, enabled him to classify the most innumerable and exceedingly complex forms of crystalline minerals in a system remarkable for its simplicity, while it affords what might justly be considered a model of a classificatory science. This presents an instance that no one should despair because a subject had presented almost insuperable difficulties to the greatest minds. Linnæus, who carefully studied the external forms of crystals, although so successful in other domains of nature, failed to discover a key to unravel the complicated forms of the mineral kingdom. The same substance which revealed, by a happy accident, to Haüy, the property of cleavage, had been carefully investigated by Newton. In his "Optics" he mentions this property, and even gives the measurement of its angles, though he failed to make the application of the fact, which brings nearly the whole range of inorganic nature within the sphere of geometry.

To give an idea of the nature of Haüy's labours, it was shown that the Comte de Bournon, in his treatise on Carbonate of Lime, had described between six and seven hundred crystals of the same substance, all differing from one another, some of the most complex presenting 40 or 50 different faces. All these were shown by measurement to possess the simplest geometrical relations to the rhomboid obtained by cleavage.

Mr. Mitchell then demonstrated, by a series of models of the cubical system of crystallography, the nature of these geometrical relations, and how bodies, at first sight apparently most dissimilar, possessed relations in common with one another. The property that all the simple bodies of the cubical system can be inscribed in the cube, and their relations to that body, as well as the process by which one body may be conceived to pass into the form of another, was shown in a variety of ways by a number of models.

A number of instances, showing the value of crystallography, not only as a means of mental discipline of the highest order, but also as of the greater practical importance to the chemist, the mineralogist, the medical man, and the manufacturer, were then mentioned. The next question was, could this subject be taught so as to bring it within the range of our elementary schools? The lecturer maintained that it could, and practically demonstrated how, by a few sheets of cardboard and a few pieces of wire, amusement might not only be afforded to children, but they might easily be brought to apprehend truths which even a mature and practised intellect would have great difficulty in comprehending from drawings on a plane surface.

A few circles of wire were combined together in such a manner as to demonstrate some of the most complicated theorems of crystallography. The opportunity was taken of impressing on the educators of youth how easily they might thus for a few pence construct instrumental aids for education, which would make many of the most difficult problems of astronomy, geography, spherical trigonometry, and solid geometry, clearly understood.

Having acquired a knowledge of the simpler forms of bodies by pasteboard models and wire-work skeletons, it was shown how readily a knowledge of their complicated combinations might be acquired by coloured diagrams and models, care being taken that the planes of the same simple form should be represented of the same colour throughout the representations of all the combinations.

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*The Swansea Docks.*—The centre, or great point stone, of the entrance-gates of these important works was laid, with some formality, but without demonstration, on the 22nd ult., by the Mayor of Swansea. The stone, a noble specimen from the Craigleith quarries, Edinburgh, weighing 7 tons, was placed in the slings of the goliah, and having been carefully adjusted, was finally set in its appointed place. Within a recess, his worship placed the various current coins of the realm, which had been expressly obtained from the Bank of England; and plans and detailed statement of the works, of its promoters, officers, &c., were likewise inclosed. The contractor, Mr. Pickering, and resident engineer, Mr. Neill, having finally proved the levels to be correct, the worthy Mayor took the mallet, and giving the stone the customary three knocks, declared the foundation-stone duly laid.

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## THE GREAT GANGES CANAL.

It is not long since, when, in the course of our comments on a pamphlet on the public works of India, published by the Indian Reform Association, we had occasion to observe that the works executed by the East India Company were not of a character to call for much notice, from those to whom the extraordinary feats of engineering skill daily exhibited in this country, were familiar. We were not, however, then aware that the completion of the great work to which we would now direct attention, was so near at hand. We had been given to understand that the Great Ganges Canal, the work to which we allude, was still in so incomplete a state as to require a much longer period to elapse than has yet taken place, ere it would be in a condition to be of any value to the district it is intended to benefit. Advices from India, however, have since informed us of its having been opened amid much rejoicing and ceremony. It is now three months since the event took place, and the nature of the works have now been tested in some degree, so that we feel ourselves at liberty to lay before our readers some account of the work—an undertaking of which it is difficult to find a parallel either in ancient or modern times, and which in its future effect on India can hardly be fairly estimated.

It is not merely a canal for the purpose of navigation and commerce, but the chief end proposed in its construction is the irrigation of a tract of country which has for centuries been doomed to aridity and waste. No work of the famous Sesostris, to whom Egypt was indebted for its numerous canals, can be compared in point of extent to the vastness of the subject of our article. Even the most famous canal of antiquity—that which baffled the skill of Sesostris, exhausted the immense resources of Darius, the Persian, and finally required all the Greek talent and Egyptian ability at the command of Ptolemy Philadelphus to complete,—the canal connecting the Nile with the Red Sea, was but 1000 stadii, or 125 English miles, in length; while the one to which we advert has a channel, navigable throughout, nearly 890 miles long, extending through a country of a nature quite as difficult, in an engineering point of view, as the one through which the great Egyptian work passed. All the difficulties presented by the country, the climate, the people, and many others not easy to define or enumerate, have been, however, overcome by the energy and skill of Lieutenant-Colonel Cautley and the engineer-officers under his command. It is no easy matter to fix the amount of credit to which they are entitled, and those who are at all acquainted with the nature of what Lieutenant-Colonel Cautley has done, will agree with us in thinking that the dignity of K.C.B. lately bestowed upon him is but a very inadequate reward for the services he has performed. With a small staff of military engineers, Colonel Cautley had to educate the whole of his subordinates, who, without exception we believe, were drawn from the rank and file of the Indian army, and such natives, as he could find suited for the employment. With such means and such assistance, has been constructed the Great Ganges Canal, which we will now attempt to describe; to do which we shall have frequent occasion to quote the pamphlet which has been published on the subject by the East Indian Government.

The River Ganges, rising among the snows of the Himalayas, leaves its mountain channel above Hurdwar, and at that point breaks through the Sewalic Hills as a pure and plentiful stream, flowing over a bed of great stones, and separating into several branches, one of which passes Pyree Ghat, the most sacred of the bathing-places of the Hindoos. The main branch turns off a little to the eastward, and flowing past Khunkhul, receives again, immediately below that town, the Pyree branch. It is through this latter channel, that the supply for the canal is brought to Myapoor, where the regular excavation commences. At Myapoor, a very extensive and complete series of works have been constructed for regulating the admission of water into the canal-bed. They consist of a great dam of masonry, 517 feet in length, across the Pyree Ghat branch of the Ganges, and a regulating bridge of ten arches, each 20 feet wide, across the channel of the canal, with gates and all the necessary machinery for regulating the admission of water, according to the wants of the cultivators on the banks of the Canal. The left flank of this bridge is connected with the dam by a line of wall, which protects the earthen bank against the action of the water, and on the right bank there are long lines of deep steps, stretching from the bridge to the branch, down which natives may come, who wish to bathe in the sacred waters. Between the Myapoor regulating bridge, and the high land on which Roorkee is situated, the most formidable obstacles have been found. They consist principally of slopes, to regulate which, four falls of 9 feet in depth have been required between Hurdwar and Roorkee, which delivers the channel on the edge of the valley of the Solani River at Mahawur, 27½ feet above the level of the lowest part of the valley. The continuation of the channel is then provided for by an earthen aqueduct, called the Solani Aqueduct, about three miles in length, protected throughout with masonry walls, having steps on their water-faces for the convenience of the natives. The Solani River is then crossed by a masonry aqueduct of fifteen arches, each having a span of 50 feet, giving a clear waterway of 750 feet for the passage of the floods of the river, which is one of the great drains of the Sewalic Hills. On this aqueduct—one of the largest in the world—the Indian Government have expended a sum of not less than thirty lacs of rupees (300,000*l.* sterling). It is founded on an elaborate series of blocks of masonry, sunk 20 feet deep below the bed of the stream, each of which measures 20 feet square. Piles and other devices for resisting the action of the stream have also been used.

Up to Roorkee, the head-quarters of the engineers and work-people employed in the construction of the works—where a college for their education was some years since founded by the late Lieutenant-Governor Thomason—the canal has cost about 700,000*l.* It thence proceeds southwards in a single line to Nanoon, a distance of 180 miles. The slopes being regulated by masonry where falls were necessary, round each of which a navigable channel with a lock is carried, for the purpose of transit. Bridges for cross communication are built at intervals not greater than three miles, and to each bridge there is attached a main irrigating channel, whereby the water is carried to the adjoining villages. The length in a straight line, as we said before, from the canal-head to Nanoon, is 180 miles; the breadth at bottom 140 feet, diminishing gradually as it reaches Nanoon to 80 feet. Between Roorkee and Nanoon, are three great branches, one leading to Futtehghur, leaving the main line at fifty miles from the head; the second to Bolundshahr, leaving at the 110th mile; and the third to Koel, leaving at the 152nd mile. The two last ultimately unite, and form one branch, used for irrigating the great district of Hatrass.

At Nanoon, the canal branches into two separate lines, directed respectively on the Ganges at Cawnpore, and the Jumna below Etawah. The total length of channel navigable throughout, including the trunk and terminal lines, with the great branches, is nearly 890 miles; along which are distributed 17 dams or escapes, with waterways, varying from 800 feet to 18 feet; 902 bridges for the purposes of regulation and cross-communication, with waterways varying from 200 feet to 20 feet; 297 inlets for local or minor drainage; 16 falls for regulating the slopes; 31 locks and navigable channels for navigation; 282 heads for irrigation; an aggregate length of not less than ten miles of steps for bathing, for the use of the natives; 170 buildings for the shelter of the establishment; 6 workshops for supplying the various wants of the canal works: all which has cost about 700,000*l.* sterling, and has been executed within the last eight years. But to quote the words of Captain Baird Smith: "The visible results are far from being a true measure of the amount of labour which has been expended. It is the work of the hand in construction only, that is seen on the surface of the country; to estimate the extent of mental and manual labour of other kinds that are here required for pure constructive purposes, the records of the office must be examined; and there will be found proofs of the thoughtful care and immense toil with which every part of the great design has been elaborated by those concerned in working it out. Nor should those who execute works of civil engineering in countries overflowing with every resource that mechanical skill and individual enterprise can supply, overlook those peculiar difficulties which beset the engineer's path in India, where his resources are chiefly in himself, and where he must not only be the designer of works, but the head mason, the head carpenter, the head brick and lime burner; in fact, the man of all detail work or of all general design."

This vast undertaking being entirely the work of government, the results, of course, constitute a portion of the public revenue, and are estimated to amount, on the gross average, to the sum of 145,000*l.* per annum. The water-rent, from the cultivators, who will use the canal for irrigating their lands, is estimated to produce about 130,000*l.* per annum, while the transit duties and other items of revenue are reckoned at 15,000*l.* The annual charge for maintenance is estimated at 40,000*l.*, and when the various contingent works are completed, the total capital sunk will be about a million and a half, on which the net income will amount to 125,000*l.*, just seven per cent. on the outlay.

But it is not merely as a stupendous work of engineering, or as a profitable investment of capital, that the Ganges Canal is most worthy of our notice, remarkable though it be in both respects: but as a boon to the countries through which it passes. As an instance of what may be done in India by the judicious expenditure of capital, its construction constitutes one of the most remarkable events that have taken place during the present age. It has been the means of bringing into regular cultivation millions of acres which for ages have lain almost waste, and only cropped in those years when the rains have been more than usually abundant; it has removed thousands beyond the dread of famine, and rendered unnecessary those periodical migrations which have hitherto characterised the habits of the people of those regions.

Although we have before given the estimated direct return of revenue from the canal, it is impossible to give any idea of what amount of increased land revenue may be indirectly realised by the government, by the construction of this great work enabling the cultivators to raise crops on those lands which before had lain waste: and not only the increased revenue, but the increased production, adding to the wealth of the country, raises the estimate to a higher figure than we would venture to name. The construction of the Ganges Canal is, in a word, the most profitable acquisition that has been made by the British empire since the conquest of Bengal, and affords a convincing proof that, as a field for the employment of capital, India is not behind the rest of the world; though, to judge by recent transactions on the London Exchange, when Indian speculations have been the subject of traffic, such would not appear to be the opinion of the commercial world generally. Another word, and we have done. It was at one time said, and perhaps truly then, that if the English were expelled from India, they would leave no traces of their sojourn behind them, but a few gaols and empty bottles. Now, however, the joke may pass harmless. The Ganges Canal is the standing answer to the sarcasm.

## MATERIALS FOR PAPER MAKING PROCURABLE FROM INDIA.

Paper, it is well-known, is in Europe made chiefly from linen or cotton rags, but also from the refuse and sweepings of cotton and flax mills, as also of the coverings of our cotton bales and of worn-out ropes. But paper is also made from the stems and leaves of many grasses, as from rice-straw and from the bamboo by the Chinese, and of late from common straw in this country, and even from wood shavings. The fibrous part of many lily and aloe leaved plants have been converted into excellent paper in India, where the fibres of tiliaceous, malvaceous, and leguminous plants are employed for the same purpose. As in the Himalayas, one of the lace-bark tribe is similarly employed, and in China one of the mulberry tribe, and the nettle in Holland. I mention these various sources, because plants belonging to the same families as the above abound in India and other warm countries, and are capable of yielding a very abundant and never-failing supply of sufficiently cheap and very excellent materials for paper-making of all kinds. Some may be used without any further process of bleaching, but all are capable of having any colour they may possess destroyed by chemical means, as I would not even except the jute canvas or gunny bagging, because I have seen specimens of jute of a beautiful silky white, both plain and manufactured into fabrics for furniture, &c., as shown by the late Colonel Calvert at the East-India House. As the Chinese make paper of rice-straw, and of the young shoots of the bamboo, while the Hindoos make ropes of different grasses (such as Saccharum munja and Saccharum sara), strong enough for their Persian wheels as well as for towing-lines, it is evident that these, and probably many others, contain a sufficiency of fibrous material for paper-making. The cultivated cereals cannot well be turned to much account, for their straw forms the chief food for cattle; but as the country abounds with grass jungles, which are in the autumn of every year burnt down in order that the young blades may spring up and afford pasturage for cattle, it is evident that there are many situations where a sufficiency might be cut down before it has become perfectly dried up, and converted into *half-stuff* for paper-makers.

Of the sedges also some are employed in India for making ropes, as the Bhabhur or Eriophorum cannabinum, for making rope bridges for crossing some of the hill torrents. The papyrus, we know, was used by the Egyptians for making their paper, but this was by cutting the material into thin slices and making them adhere together under pressure. But others of the genus, as the Cyperus tegetum, is used in India for mat-making. As these plants as well as rushes grow together in large quantities, it would be quite possible in many places to turn them to profitable account.

Many parts of the world abound in the lily and aloe-leaved plants which have been alluded to above, and of which the leaves contain much easily separable fibrous materials. These belong to the genera Agave, Aloe, Yucca, Sausevieras, Bromelia, and others; all of which abound in white-coloured fibres, applicable to various useful purposes, and of which the tow might be used for paper-making, and considerable supplies obtained. Paper used to be made from the Sausevieras in Trichinopoly, and some made of the unbleached Agave alone, and also mixed with old gunny bags.

Among cultivated plants there is probably nothing so well calculated to yield a large supply of material fit for making paper of almost every quality as the plantain (*Musa paradisiaca*), so extensively cultivated in all tropical countries on account of its fruit, of which the fibre-yielding stems are applied to no useful purpose. The plant, as every one acquainted with tropical countries knows, is common near the poorest huts and in the largest gardens, and is considered to yield by far the largest quantity of nutritious matter. Its fruit in many places supplying the place of bread, and in composition and nutritious value approaching most nearly to the potatoe, may, if produced in too large a quantity, be preserved in the same way as figs, or the meal may be separated, as it resembles rice most nearly in composition. Each root-stock throws up from six to eight or ten stems, each of which must be yearly cut down, and will yield from three to four pounds of the fibre fit for textile fabrics, for rope-making, or for the manufacture of paper. As the fruit already pays the expenses of the culture, this fibre could be afforded at a cheap rate, as from the nature of the plant, consisting almost only of water and fibre, the latter might easily be separated. One planter calculates that it could be afforded for 9*l.* 13*s.* 4*d.* per ton. Some very useful and tough kinds of paper have been made from the plantain, and some of finer quality from the same material in France.

All the plants which have been already mentioned are devoid of true bark, and are called endogenous in structure. Simple pressure between rollers, and washing, would appear to be sufficient for the separation of the fibres of most of them. But the following families of plants are all possessed of true bark, which requires to be stripped off usually after the stems have been steeped in water, before their respective fibres can be separated from the rest of the vegetable matter.

The flax plant abounds in fibre, but this is too valuable to be converted into paper. India, however, grows immense quantities of the plant on account of its seed (linseed), which is both consumed in the country and exported in enormous quantities, but nowhere is the fibre turned to any account. This is no doubt owing to the climate not favouring the formation of soft and flexible fibre; but the short fibre which is formed, and might be easily separated, would be valuable for paper-making, and might add to the agriculturists' profits without much additional outlay.

So some valvaceous plants are cultivated on account of their fruits, being used as articles of diet, as the Okhro (*Hibiscus esculentus*) of the West Indies and of the United States. The *Ram-turai* of India is closely allied to it, and is cultivated for the same purposes. Both plants abound in fine flexible fibre, which is not, but might be easily, separated, and afford a considerable supply, especially if the cultivation was extended in the neighbourhood of towns. Paper is made from a species of Hibiscus in Japan, and *Hibiscus Sabdariffa* is cultivated in India on account of its jelly-yielding calyxes. Numerous other species of Hibiscus, of Sida, and of other genera of this family abound in warm climates; several are cultivated in different countries; as *Hibiscus Canabinus* in India, and *Sida Tiliaefolia* in China; more might be so. They grow quickly and to a large size, and abound in fibrous material of a fine, soft, flexible quality, on which account they might be cultivated with profit, and the tow be useful to the paper-maker.

The Tiliaceæ are likewise remarkable for the abundance and fine quality of fibre which many of them contain. *Tilia Europea* produces the enormous quantities of bast exported from Russia. *Corchorus olitorius* and *Corchorus Capsularis*, the leaves of both of which are used as a vegetable, yield the large supply of jute imported into this country, as well as the gunny cloth and bags exported even to America. Several species of Grewia yield edible fruit, on which account they are cultivated. Others abound in the jungles, and most would yield a valuable fibre, as some of them already do, for commercial purposes. Some paper is made from gunny bags. Some of the Leguminosæ also abound in valuable fibre. *Crotalaria juncea* yields the common sunn of India. *Sesbania Cannabina* yields the dhanchi of Bengal; while *Bauhinea Racemosa* is used in making rope bridges in the Himalayas. The fibre of *Parkinsonia aculeata* was sent to the Exhibition in 1851 expressly as being fitted for paper-making; though colourless it wants strength.

Several plants produce large quantities of a silky, cotton-like substance, not applied to any use, such as the silk-cotton tree, the mudar of India, &c., several species of Saccharum, which might be collected where labour is cheap, and would no doubt be well fitted for conversion into pulp for paper.

Among the nettle, the mulberry, and bread-fruit tribes of plants, there are many which seem well calculated to yield material for paper-making. The Chinese, we know, employ the inner bark of morus, now *Broussonetia papyrifera*. This, no doubt, produces some of the Chinese paper, which is remarkable for toughness; I believe that the refuse cuttings of the bush cultivation of the mulberry in Bengal might be turned to profitable account. The barks of many stinging (*Urtica*) and of stingless (*Bohemeria*) nettles abound in fibres remarkable for strength; the tow of these might be converted into paper stuff if not required for mixing with wool.

The weeds of tropical countries, which grow in such luxuriance, and among which are species of sida, of grewia, of corchorus, of triumfetta, and of many other genera, might all yield an abunddance of fibrous material if the refuse of the above cultivated plants was found not to be sufficient. Some simple machinery for separating the fibre would greatly facilitate operations, while the expenses of freight might be diminished by compression, or, as suggested, by packing the material as dunnage; and the cheapness of labour, as of everything else in many of these countries, would enable material for paper-making to be brought here in great abundance, and at a sufficiently cheap rate, if ordinary pains were taken by the consumers in Europe to encourage the planter or colonists of a distant region.

J. Forbes Royle.

*East India House, May* 3, 1854.

## ON THE RAW MATERIAL FOR THE MANUFACTURE OF PAPER.

It is unquestionably true that there is a great and increasing scarcity of the raw material used in paper-making. The cause of this scarcity, in spite of an increased demand, would appear to depend on the circumstance that the raw material of papermaking is in reality the product of the wear and tear of a substance of very advanced manufacture, and depending for its quantity on the collateral causes which produce a greater or less activity in the latter. Hence the stoppage or partial suspension of linen and cotton manufacturers is sufficient to account for occasional and especially for local scarcity. Thus the paper-mills have been influenced by the lock-outs of Wigan and Preston, and the half-time working of Belfast and the surrounding districts.

It would appear, also, that apart from occasional depressions of the manufactures, or the wear and tear of which the raw material of paper chiefly depends, the demands of the paper-makers have been greater than can be supplied by the *less* increased rate of consumption of the manufactured products. While this has been the case, other consumers of the raw material have come into existence, railways and steam-boats now exhausting a very large quantity of cotton and other waste for wiping machinery. But the most important of all new competitors have been undoubtedly the Americans, who have purchased not only largely in our own markets, but also in those foreign parts which are open for the sale of rags. It may be mentioned also, that the rag trade is in the hands of only a few capitalists, who buy from small collectors and import from abroad, and that this limitation of the trade enables them readily for a time to influence the market, both as to supply and price, by withholding their stocks, but these influences can only be temporary, and cannot be persevered in for long periods.

The disadvantage of the *raw material* of paper-making being dependent upon manufactures having no immediate relation to its supply and demand, and the fact, also, that the growing thirst for literature is at a greater rate than the increase in the manufacture of cotton and flax, seem to furnish adequate reasons why the supply of rags does not meet the increased demand.

Many attempts have been made to furnish new raw materials for paper, but hitherto with only partial success. The failure generally results from one or more of three causes. (*a*) Some fibres require so much cost to bring them to the state in which they are offered to paper-makers, in the form of rags or cotton waste, that in point of economy they cannot enter into competition with the latter. (*b*) Certain fibres lose so much weight in bringing them to this state that they cease to be economical. (*c*) Certain fibres, which are well adapted on account of their texture for the paper trade, present so many difficulties in bleaching them as to render them unfit for white paper. The Surat bass in which cotton has of late years been imported into this country, offers an example of this difficulty.

The price which is mentioned in the Treasury letter, of 2*d.* to 2½*d.* per lb. for a partially-prepared pulp is generally considered by most makers to be too high, and they think that materials to be of benefit should be looked for at the price of 1*d.* to 1½*d.* per lb. The latter price refers to *roughly*-prepared pulp, but should the pulp be offered in a bleached state, or in as far an advanced state with regard to colour and texture as cotton or linen rag, then 2½*d.* to 4*d.* per lb. might be obtained. The quantity of any promising material sent home for experiment should not be less than half a ton in weight.

In considering this subject, it appears that very little is known of the statistics of the consumption of various materials used in the manufacture of paper, and that an inquiry on this subject would be useful.

Lyon Playfair.

To Sir J. E. Tennent, Board of Trade.

## CONDITION OF THE THAMES MARSHES.

*The Select Committee appointed by the House of Commons to inquire into the Sanitary and Agricultural State of the Marshes on the Sides of the Thames, the Means for their Improvement, the existing Legal Powers for the Purpose, and the Necessity for further Legislation thereon—Have agreed to the following Report, dated July 17th:*

The terms of the order of reference to the Committee would have admitted of a more extended investigation; but the committee have felt justified, at the present period of the session, in confining their inquiry to the condition of the Marshes on the banks of the Thames below London Bridge, which it appears extend over 32,000 acres, and are under six distinct commissions of sewers.

It appears from the evidence of highly intelligent and eminent gentlemen of the medical profession residing in the neighbourhood of the marshes on both sides of the Thames below London Bridge, that the diseases prevalent in those districts are highly indicative of malarious influence, ague and fever being very prevalent; and that the sickness and mortality is greatest in those localities which adjoin imperfectly drained lands, and far exceed the usual average; and that ague and allied disorders frequently extend to the high grounds in the vicinity. In those districts where a partial improvement in the drainage has been effected, a corresponding improvement in the health of the inhabitants is perceptible.

The Committee have inquired more particularly into the state of the marshes adjoining the Royal Arsenal at Woolwich, which they had reason to believe gave a fair representation of the state of the other marshes.

The mortality of Woolwich, particularly East Woolwich, is much higher than the average. Woolwich adjoins the Plumstead and Erith marshes, where the water is frequently dammed up, which increases the quantity of decaying vegetation and malaria, and the description of ague from which people suffer in that neighbourhood is stated to be very distressing, and to produce many complications of disease.

It appears also, that in the neighbourhood of Woolwich and Charlton, many houses have been built, and are building, whose drainage empties itself into the marsh ditches; this seems to your Committee a new source of miasma of dangerous character, and one likely to increase.

To remove such evils is an object obviously deserving the attention not merely of the landowners and residents in the district, but of the legislature, and it is most satisfactory to find, from the evidence before your Committee, that there is good reason to believe that the increased value given to the lands by improved drainage would be such as amply to remunerate the proprietors for the necessary cost attending such works.

And with regard to the means to be employed, it was proved that no engineering difficulties exist.

The existing legal powers of the Commissioners of Sewers are inadequate to effect these objects. The authority of the Commissioners enables them to maintain existing works, but they cannot interfere with the private ditches, nor can they construct any new works without the previous consent of three-fourths of the owners and occupiers.

It appears, however, that any plan of effective drainage would require an amount to be expended in a single year, which, in justice to all interests, should be raised by loan, and repaid by annual instalments, spread over a period of years.

In order to carry out the improvements which the Committee consider to be indispensable, it will be necessary to provide some means for ascertaining the due proportion of interests in the lands to be dealt with, which shall be sufficient to bind the minority. The Committee suggest, that the poor's rate assessment offers, at the present time, the best criterion for ascertaining the proportionate interests.

The Committee recommend that additional powers be given by the legislature to the Commissioners of Sewers to enable them to carry out a more effective system of drainage, which would be beneficial alike in a sanitary and agricultural point of view. The Committee further suggest that the number of the Commissioners should be diminished, and that an alteration might be advantageously made in the mode of their appointment by the introduction of the elective principle.

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*Estimate of the Expense of Draining the Marshes or low lands between Woolwich and Erith.*

TO THE COMMISSIONERS OF SEWERS OF DARTFORD AND OTHER LEVELS.

GENTLEMEN—Having received instructions from your clerk, Mr. Hayward, to make a report and estimate of the expense of effectually draining the marshes or low lands between Woolwich and Erith, I have caused the levels to be taken, to ascertain the heights of the present sluices above low-water mark, and collected other information that will enable me to comply with the instructions.

I find that low-water mark on the 1st and 2d instant, was about—4 feet below the Green Level Sluice; 6 ft. 2 in. below the Great Breach Sluice; 3 ft. 8 in. below the Abbey Level; 6 ft. 6 in. below the Old Corn Marsh; 5 ft. 6 in. below the Crab Tree.

The land in Green Level being higher than that in the other levels, it can be drained through the present sluice.

I should recommend a new sluice to be placed in Great Breach Level, about five feet lower than the present one.

In Abbey Level I should fix a new sluice, about two feet, or two feet six inches lower than the present one.

A new sluice should also be placed in Old Corn Marsh Level, five feet lower than the present one, and through this I would drain most of Church Level, a small portion of Abbey Level, which is very low and near the sluice, and also that part of Crab Tree Level east of the Griffin Manor-way.

By placing the sluices in this way, and diverting a portion of the drainage from Abbey Level, it will be seen that the water would be taken to the Thames, from the uplands, by a shorter route than if allowed to pass through Abbey Level, as it now does.

The putting down of the three new sluices, and sinking the whole of the main drains to a proper level, to admit of thorough draining being adopted in all the levels, I estimate at 1680*l*.

I should recommend that the whole of the private ditches, except those that can be filled up, be sunk to an average depth of two feet below their present level, which could be done at a cost of about 1560*l*.; and I am of opinion that it would be much to the interest of both landlords and tenants if a proper arrangement were made, and these ditches taken into commission, because they could then be kept clean and a proper supply of fresh water given for cattle, without the interference of any of the occupiers.

The fresh water must be supplied, I find, in a similar manner to what I recommended in my report, dated December 1847, but at two feet lower level, and this alteration I estimate at 160*l*.

The alteration made in the level of the fresh water in the ditches would involve the necessity of making drinking places for the cattle, and I am of opinion that 200*l*. would make all that would be wanted.

If the whole of these works were to be carried out, the cost, per acre, for all the levels would be under 25*s*., the total amount being 3600*l*., and the number of rateable acres 2923.

I have measured the length of the ditches in the levels, as shown on the plans, and find them to amount to 141,980 lineal yards; and, taking them at an average width of seven feet, the area would be equal to 68¼ acres, and of this extent I find we could stop up 12¾ acres without any exchange of property. But if the whole of the levels were the property of one landowner, a very much larger number of ditches could be done away with.

I was glad to learn, while collecting information for making this report, that ague had very much diminished since you carried out the works recommended in my report of December 1847, for lowering the main sewers, and for improving the supply of fresh water to the levels.

Should the plan here suggested be carried out the whole of the levels could be thorough drained, which would not only improve the district in a sanitary point of view, but would, I am confident, from my experience in thorough draining, pay the landlord and tenant together from 10 to 15 per cent. for the money expended.

There is one other subject to which I must beg to draw your attention, viz., the sewage and drainage of the new town now growing up between Plumstead Common and the railway, which is now taken along the railway into the Crab Tree Level. This is but very little, if any, nuisance at this time, but it will become worse every year, as the town increases; and therefore I think it right to draw your attention to it, the more particularly as I am not certain at whose expense it ought to be conveyed into the Thames without going into the level, which could be done at a cost of from 1600*l*. to 1700*l*.

I think, however, that you ought not to be called upon to do it, and, therefore, the question would rest between the North-Kent Railway Company and the proprietor of the land on which the town in question is growing up.

(Signed) JAMES EASTON, for Self and Partner.

*Grove, Southwark, December* 8, 1853.

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Upon this report a meeting was called; a circular was sent to each landowner and each land-occupier, giving notice that a meeting of the Commissioners of Sewers would be holden very shortly after that date at Dartford, at which they would present before them a system of drainage throughout the district from Woolwich to Erith, and that they would be solicited to give their assent. The meeting was attended numerously. Mr. Easton was there, and he produced his plan, and explained the mode he had of doing this drainage; it resulted in the consent being signed by five persons as owners, two of them being commissioners themselves, and one occupier: there the matter has remained, and there have been no active steps taken since that meeting.

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## OBTAINING LIQUID CEMENT, AND PIGMENTS OR PAINTS.

GEORGE BELL, *Patentee*, May 11, 1853.

THIS invention relates to combinations of lime with certain other matters in the production of liquid cements, pigments, and and paints.

In carrying out this invention, when it is required to produce a liquid cement suitable for outside walls and other like situations, the following matters are mixed in the proportions given: viz., six bushels of slacked lime, one pound of sulphate of iron or zinc, one quarter of a pound of sal-ammoniac, ground in a little water; six pounds, or thereabouts, of ochre, and six pounds, or thereabouts, of umber, being added thereto to give the required tint to the mixture. If the mixture, when ground, is not sufficiently fluid for use, the same may be rendered so by the admixture therewith of water to the extent desired.

To produce a liquid cement or colour, having a more adhesive character, and suitable for inside walls and other situations, six pounds weight of gum-arabic and one-and-a-half pounds of bees'-wax are added to and dissolved and mixed with the above.

To produce a black paint for common purposes, the following matters are combined in the proportions given:—Two pounds of slacked lime in powder, two pounds of sulphuric acid diluted in one gallon of water, and ten gallons of gas tar. These are mixed together in any suitable stirring apparatus, and are then fit for use.

An elastic paint, suitable especially for damp walls, but applicable for other purposes, is produced by combining one hundred-weight of oxichloride of lead or oxide of zinc, twenty-eight pounds of slacked lime, dry, and one gallon of a solution of india-rubber, diluted with one part of linseed-oil and two parts of spirits of turpentine. In obtaining this latter combination, the oxide of zinc or oxichloride of lead is first mixed with linseed-oil by grinding, and then the other matters are added as may be desired.

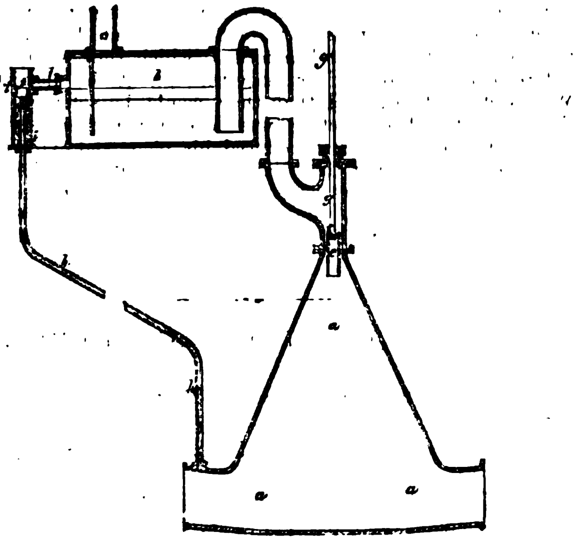
An oil suitable to be used for thinning the last-mentioned combination, of elastic paint may be obtained by combining one gallon of spirits of turpentine, half a gallon of turpentine varnish, one pint of linseed-oil, and one pint of rosin-oil.

Each of the above combinations may be applied by brushes in the ordinary manner of applying paint.

## MANUFACTURE OF GAS.

RICHARD HOLME, *Patentee*, August 1, 1853.

THIS invention consists of constructing retorts with enlargements or chambers at the upper parts, so that the gas as it is evolved, in place of passing away out of the retorts by the rising pipes, as heretofore, is received into the upper parts or gas chambers of the retorts, where there is constantly a quantity of gas, and it is from these chambers the gas is conveyed to be purified, and then to the gasometer. The retorts are each made either with one or two mouth-pieces, and the bottom of the retort rises towards the mouth-piece or mouth-pieces, so that the fluid flows towards the most heated part of the retort, and is converted into gas. And when the retorts are used for making gas from oils or fluids, they are supplied by means of a tube rising into a cylinder closed at bottom, and over such tube there is an inverted vessel, by which there is at all times a fluid joint found, opposing the passage of gas through the hole in the tube, by which the fluid passes into the retort.



The engraving shows a vertical longitudinal section of a retort constructed according to this invention. It may be made with doors at each end, or at one end only, and the ends of the retort rise from the central portion, whereby any fluid therein will flow towards the hottest part of the retort. The retort is made with a conical chamber over the central portion, as shown, into which the gas rises as it is evolved. The retort *a*, is to be set in such manner that the bottom may be heated the hottest, and the upper parts of the retort are also to be heated; the heating of these retorts, as with others, is to be according to the materials which are being distilled, which is well understood by gas engineers. The gas passes off at the upper part of the conical chamber of the retort into the hydraulic main *b*, as shown, and it passes from the main by the outlet-pipe *c*. In the hydraulic main there is a partition to prevent the gas getting away at the outlet *d*, where the tar is allowed to flow off; *e*, is a tube suspended on the plate or disc *f*, fixed to the rod *g*, which passes through a stuffing-box. This apparatus partly stops up the passage at the top of the retort, and carbon accumulates therein, and the same is to be cleared out by pressing down the rod *g*, when the lower end of the tube *e*, coming down on the contents of the retort, the disc will be forced down, and remove any matters which may have accumulated in the tube *e*. The tar accumulating on the water in the hydraulic main is allowed to flow away, there being a small opening in the partition for that purpose just above the water. The tar returns to the retort *a*, by the tube *h*, which enters the vessel *i*, and is covered by the inverted vessel *j*, there being openings for the passage of the tar under the inverted vessel *j*. The retort may be used for distilling from coal or other matters, and when fluids be used, such as resin or other oils, they are supplied to the retort by an apparatus, such as is used for conveying back the tar to the retort.

The patentee does not confine his invention to the use of the precise form of retort shown, as it may be somewhat varied, without departing from its peculiar character.

*Claim.*—The construction of gas retorts with upper chambers, wherein there will, when at work, be constantly an accumulation of gas.

## FORMING DESIGNS ON PAPIER-MACHE.

CHARLES BREESE, *Patentee*, July 19, 1853.

THIS invention consists in first producing a pattern or design upon paper by printing from stone or other surface in some adhesive material or composition, which is transferred to the surface intended to be ornamented. The paper is removed, and the pattern has applied thereon some material or composition in a finely-pulverised state, which will resist the action of acids or other agents employed to act upon that part of the surface not covered by the pattern. Or instead of the pattern being so treated only after being transferred, in some cases it is submitted to the like treatment on the paper, then transferred, the paper removed, and the process proceeded with as above described. When required to ornament glass and metal surfaces with vitrifiable colours or with metals, the process known in the trade as burning-in is employed. The vitrifiable colours or metals (in the state of powder or leaf) are rubbed into, mixed with, or applied on the pattern produced in the resinous or other material or composition aforesaid. When not required for burning-in, and for the purpose of producing designs and patterns in colours or in gold, silver, or other metal, the pattern is produced in an adhesive composition as aforesaid, and has applied thereon the gold, silver, or other metal in the state of powder or leaf; the superfluous metal being wiped away or removed from those parts where the adhesive composition has not been applied. Or the whole surface is covered with gold or silver leaf, and the pattern, produced in an adhesive composition and sprinkled with a resinous powder, is applied thereon. The gold or silver leaf is removed from those parts which the pattern does not cover by biting with acid or by simple rubbing. The resinous composition is next washed off with spirits of turpentine or other solvent, and the pattern appears in bright gold or silver.

In carrying out this invention, the pattern is first drawn or otherwise produced upon stone, copperplate, or other surface, or in type, in the usual way, and an impression in an adhesive matter or composition is obtained upon paper or other suitable fabric. A good adhesive composition for the purposes of this invention may be formed as follows:—Linseed-oil boiled till it assumes the consistence of putty, and thinned to the required consistence for printing with, that is, about that of ordinary printing-ink, by the addition of gold size, to which is afterwards added a portion of pitch. The pattern is transferred to the glass intended to be ornamented, whether plain or coloured (supposing the pattern to be produced on glass), and the paper moistened (when necessary) and drawn off. Some material or composition which will resist the action of acids or other agents, such as finely-powdered asphaltum or anthracite coal reduced to fine powder is then applied; or in some cases metal or other leaf, which adheres to the pattern only, and renders it impenetrable to the acid or agent to be afterwards employed, is used. In some cases heat is applied, or time is allowed with or without exposure to the vapour of spirit or oil, to enable the resinous or other material or composition employed to incorporate itself with the impression; and then fluoric acid (or other material having similar properties) is applied in the usual way on the face of the glass. Th will bite away from every part of the glass where the pattern does not extend, and will leave the pattern untouched.

In some cases the resinous or other powder is applied before as well as after transferring the pattern, and the operation is then proceeded with as follows:—Supposing the pattern to have been produced upon paper in the ink usually employed in lithographic printing, while the ink is still wet or damp a resin or resinous composition reduced to powder is applied thereon. The paper is exposed to the vapour of turpentine in order to cause the resin and oil in the lithographic ink to combine and form a varnish. Or, instead of exposing it to the vapour of turpentine, it may be exposed to heat or even allowed to remain a certain time, when the matters will of themselves combine and form a varnish. The pattern is then transferred on to the article to be ornamented, and the paper on which the pattern had been produced and treated as aforesaid is either stripped or washed off. In some cases an adhesive composition of a watery character is used for obtaining the impressions for the purpose of transferring. Gum or other suitable substance, in a state of powder, is then applied to the printed parts of the impression, either before or after transferring, or both before and after; and the process is proceeded with in other respects as before described. For the purpose of dissolving the gum applied as aforesaid, the surface is exposed to the vapour of water, or left for a short time exposed to a damp atmosphere, instead of using the vapour of oil or spirit and heat, as directed in the case of the resinous composition. When it is desired to obtain an impression of a very adhesive character, a lithographic stone or metal plate is employed, having those parts of the surface on which the pattern is produced in relief, or raised above the other parts of the surface of the stone or plate.

For forming designs in vitrifiable or fusible colours or metals on glass, china, and other suitable substances, the pattern produced by printing in an adhesive material is first taken, with or without the addition of the resinous composition, and transferred as before; and the colouring medium is then rubbed into the pattern; or if metal, it may be applied in the state of powder or leaf. The article is next subjected to heat, when the composition will disappear, and the colour or metal will adhere by fusion to the surface of the article. In some cases the colouring medium may be mixed with the adhesive composition before obtaining the impression, or it may be applied to the impression before transferring it to the surface of the article.

For producing patterns in dead gold, silver, and metal leaf or bronze powder, upon hard or bright surfaces (such, for instance, as japanned iron, papier-maché, oil-cloth, &c.), the pattern is first obtained in an adhesive composition as aforesaid, and transferred to the surface; the leaf or powder is then applied, and wiped off from those parts where the pattern does not extend. When necessary, the article may be subjected to the usual after-processes of stoving, varnishing, polishing, &c.

For producing designs and patterns in burnished gold or silver, gold or silver leaf is first applied by means of the ordinary gilding water, or in such manner as to cause it to adhere sufficiently to the surface of the ~~article to be~~ ornamented. A pattern or design produced in some adhesive composition, sprinkled with a resinous or other powder as aforesaid, is applied thereto, and the gold or silver leaf is removed from all parts which the pattern does not cover by means of an acid or by simply rubbing it off. The material or composition is next washed off, and the pattern is covered with spirit of turpentine or other solvent, when it will appear in bright gold or silver.

This process is also applicable to ornamenting metallic surfaces covered with gold or silver by what is known as the amalgamation process. In this case an impression is obtained in a resinous composition as aforesaid, and transferred to the surface to be ornamented; and acid or other agent is then used to bite away or remove the gold or silver from those parts not protected by the transferred impression. The resinous composition is finally removed by washing with spirit or other solvent.

For the purpose of ornamenting marble, wood, &c., impressions, obtained as aforesaid, are transferred to the surfaces thereof (those in watery compositions are, however, preferred), and dyes, pigments, or varnishes, or any required colour, are then applied to the surface; after which the transferred impression is removed, and the pattern of the original colour is left, surrounded by a ground of the colour produced by the dye, pigment, or varnish.

The patentee claims the method of forming designs and patterns upon papier-maché, japanned iron, glass, metal, and other surfaces, by printing any required design or pattern in an adhesive matter or composition; which design or pattern, so produced, is transferred to the surface to be ornamented, and has applied thereon, either before or after transferring, or both before and after transferring, a substance or composition possessing the properties hereinbefore described, whether employed to stop out the action of acids or other agents applied to those parts of the surface not protected by the pattern; whether vitrifiable colours or metals in the state of leaf or powder for burning-in are rubbed into or applied on it; whether colours in the state of powder, or metallic powder, or metal leaf are applied thereon or mixed therewith; or finally, whether employed to protect a surface of gold or silver leaf, all as hereinbefore described.

## ELECTRIC CONDUCTORS.

THOMAS ALLAN, *Patentee*, August 12, 1853.

THE engineering as well as the electrical difficulties to the laying down and working submarine telegraphs of any great length, extending much beyond what has already been accomplished upon the plans at present known, have led to the belief that other means were requisite, and that a different mode of applying known principles and materials would be necessary to obtain not only the greatest length of rope at the smallest amount of weight consistent with sufficient strength, but also the fullest amount of electrical conduction.

The invention consists in forming the electrical conductors of submarine and subterranean telegraphs of iron rods, wires, or strands of wires, insulated or otherwise, in lieu of copper as now used.

For submarine telegraphs, the patentee substitutes for the insulated copper wire conductors protected with iron, a stout iron wire or rod, or, what is preferable, a rope or strand of wires, which thus forms not only the conducting medium, but also the rope itself. When insulated, the iron need not be galvanised, thereby maintaining the full strength of the iron, besides effecting a great saving in cost.

The insulating medium requires to be of a material differing from that now used for the insulation of copper wires, and what is employed for the purpose is a compound of caoutchouc, sulphur, and coal-tar, or other similar substance, baked hard, and resembling in appearance the material manufactured according to the invention of Mr. Goodyear, for which letters patent for England were granted to Moses Poole, the 18th September 1852, and which itself might be employed with or without certain modifications. By these means a submarine rope will be produced of the required weight, with the greatest amount of strength that can be obtained from iron of the best quality, whilst the conducting medium will be considerably better, and give less resistance than the copper wire now used for such purpose, besides which many other electrical difficulties will be overcome which it is not requisite to enter upon here.

The patentee further adapts and substitutes iron wire or strands of small wires, insulated or otherwise, in lieu of copper, for underground electric conductors, and this, with an insulating material of the nature before mentioned, will effect a great saving of cost.

In some cases for the above purposes strands of wire of two different metals are used, that is, six or more iron wires with a centre core or wire of copper or zinc; by this means, according to circumstances, a better conductor can be obtained than by the use of iron alone, and such conductors may be used for overground telegraphs and suspended by means of posts, as well as for underground and submarine telegraphs. Under certain circumstances the patentee would employ the before-described conductors without insulation at all.

The second part of this invention consists in a cheap and efficient mode of insulating electric conductors of copper, iron, or other metals (for subterranean telegraphs, but which may also be used for submarine purposes). The conductors are insulated in the aggregate, that is, several at a time, by means of a die or dies of the form or construction hereafter described, by means of which a larger amount of the insulating material is saved, whatever that may be composed of.

The object is not merely to coat or cover the wire with two or more coatings of any insulating substance at one operation, but especially to cover three, five, or seven, or any number of wires all at one operation, and all conjoined in one rope. For this purpose, in the die-piece are placed two or three hollow mandrils (according to the number of coatings), the one behind the other; the first one at the back where the wire enters having the smallest aperture, the second being larger, and the last the full size to which the wire is to be covered, there being sufficient space between each to allow the insulating material to come freely in contact with the wire after each successive coating. To perform the same operation in the aggregate (say on seven wires), seven such series of hollow mandrils will be required, and worked in similar manner as if they were but one; and if required to be formed into one rope the die will require an extra mouth-piece, so that the seven wires, when twice or thrice covered separately, may be again covered and conjoined all into one rope.

*Claims.*—1. The adaptation of iron rods, wires, or strands of wires, or of strands of wires of different metals (insulated or otherwise) for submarine and subterranean telegraphs; 2. The mode of insulating several wires at one operation, as hereinbefore described.

## BORING ROCKS FOR BLASTING.

HENRY KRAUT, *Patentee*, September 15, 1853.

THIS invention consists in an improved tool or borer for cutting out a chamber at the bottom of the hole made by the common jumper generally used for blasting; which chamber is intended to receive the powder or other explosive agent.

In the annexed engravings, fig. 1 represents an improved borer for cutting out chambers in holes of larger diameter, with part of the rock in section, showing a portion of the hole made by the common jumper, as well as part of the chamber; and fig. 2, is a ground plan of the same. Fig. 3, is an improved borer for holes of smaller diameter, with part of the rock in section, showing a portion of the hole and chamber; and fig. 4, is a cross section of the same.

FIG. 1.

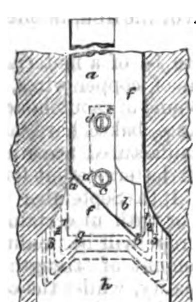
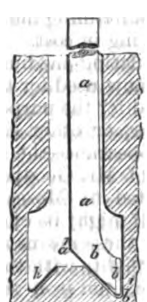


FIG. 2.



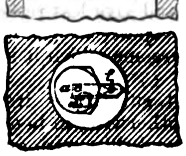


FIG. 3.

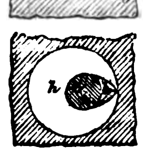


FIG. 4.

*a*, is a bar of iron, at the lower end of which a steel blade *b*, is inserted into a groove *c*, and secured by pins or sets screws *d*. From the side opposite the cutting-edge *x*, of the blade *b*, the bar *a*, and blade *b*, are tapered off, so as to form an inclined plane *a'*, *b'*, of any desired angle. *f*, represents the hole made by the common jumper reaching down to the dotted line *g*. After the common jumper is withdrawn from the hole *f*, the improved borer *a*, is introduced into it, and brought to act upon the rock in the same manner as the ordinary jumper, either by means of hammers or by the process usually called "churning,"—one man guiding and turning it round. It is evident that every time the borer is made to descend, the incline plane will force the edge *x*, of the blade *b*, laterally into the rock; whilst the bottom part of the blade will, to some extent, cut the rock in a vertical direction; and thus a chamber *h*, will be formed progressively in a manner similar to that indicated by the dotted lines 1, 2, 3, &c. From the time the chamber has been widened by twice the distance the blade *b*, projects beyond the bar *a*, or thereabouts, the continued action of the borer will increase its depth only. The conical elevations $1^1$, $2^1$, $3^1$, &c., which are formed during the process of boring, will, in some instances, have to be removed with the ordinary jumper; the loose stone and sand being scooped out, from time to time, by means of the scraper, in the usual way.

In the borer shown at fig. 3, the part *b*, *b*, is of solid steel, and welded on to the iron rod *a*; it is represented as arrived at the bottom of the chamber *h*. The length of the cutting-edge *x*, in figs. 1, and 3, varies according to the hardness of the substance to be cut. For hard stone, the cutting-edge has to be made as short as or shorter than that shown in fig. 3; and, for soft stone, it may be made as long as or longer than in fig. 1. In determining this length, however, the operator must be guided by experience.

This method of blasting effects a great saving in time. It is well known that three men will bore a hole of $1\frac{3}{4}$ inch diameter to a given depth, in one-third of the time required for a 3-inch hole. And as a chamber of 3-inch diameter at the bottom of a bore of $1\frac{3}{4}$ inch diameter, answers the same purpose as a uniform hole of 3-inch diameter made by the common jumper, it is evident that, making a liberal allowance for the time required to form a chamber, the economy of labour must amount to at least 40 or 50 per cent. And, in the second place, it is clear that a given quantity of powder deposited in a chamber formed as described, must produce a far better effect than if it were placed in a hole of uniform diameter.

The patentee does not confine himself to the particular shapes of the borers shown and described; but he claims, firstly,—the projecting part or blade *b*, of the borer; and, secondly,—the inclined plane *a'*, *b'*, at the lower end of the borer, for the purposes hereinbefore described.

## RAILWAY AND OTHER BREAKS.

JOHN JENNINGS, Jun., *Patentee*, February 11, 1854.

THIS invention relates to an improved construction of self-acting break for railway carriages, trucks, and other conveyances, and consists in attaching a spring to a break in connection with the buffers of the train, so that when the steam is shut off the momentum of the carriages behind the engine acts upon the buffers and springs, and the breaks are thereby caused to press upon the wheels, gradually stopping the train without inconvenience to the passengers. One of these breaks is applied to every wheel, or as many as may be required to stop the train in case of sudden danger. In applying the break to common road carriages, the backing action of the horse in descending a hill causes the break to bear upon the wheels, thereby tending in a great measure to retard the motion of the vehicle. In conveyances of two wheels, a slide will be employed in addition to the break, which will allow the body of the vehicle to move back on the axle in descending a hill, thereby lessening the weight on the back of the horse when a backward pressure is exerted. In ascending a hill, the body of the vehicle is moved forward over the axle, to bring the weight more over the back of the horse.

## ARTIFICIAL STONE.

FREDERICK RANSOME, *Patentee*, July 13, 1853.

IN the manufacture of artificial stone and such like wares by the use of soluble silicate, difficulty has been found in obtaining soda free from impurities, particularly from sulphuric acid, which is apt to produce an efflorescence from the stone under variations of the atmosphere. This invention consists of employing baryta, or salts of baryta, or any of the salts of lead, to neutralise such impurities, and the patentee finds such artificial stone considerably improved by exposing it, when moulded, to a bright red heat in a suitable muffle or kiln.

In the specification of a patent granted to him on the 22nd of October, 1844, the patentee described means of manufacturing artificial stone by employing a solution of silica, and he explained how he prepared soluble silica for such purposes. According to his present invention he carries on the manufacture of artificial stone as formerly described; but, in order to prevent efflorescence in such artificial stone after it is manufactured, he causes the solution of caustic soda used in preparing soluble silica to be first deprived of its impurities by applying a solution of baryta, and this is done by adding the solution of baryta to the solution of caustic soda, till no further precipitate is caused by such addition.

The solution of caustic soda is then separated or drawn off from the precipitate, and employed as formerly described in the manufacture of artificial stone. Although the patentee prefers to use a solution of baryta for the purpose of removing impurities from the solution of caustic soda used in the manufacture of artificial stone, he does not confine himself thereto, as a solution of a salt of baryta may be employed, or any salt of lead may be used in a similar manner. The articles of artificial stone manufactured according to the invention, after they are well dried, are then raised to a bright red heat in a suitable muffle or kiln, and are then allowed to cool slowly.

*Claim.*—The employment of a caustic solution of soda, deprived of its impurities, in the manufacture of artificial stone; and also the subjecting articles of artificial stone, made as described, to a red heat.

## NEW TRUSS BRIDGE.*

G. W. Thayer, *Patentee*, U.S., April 11, 1854.

Fig. 1.

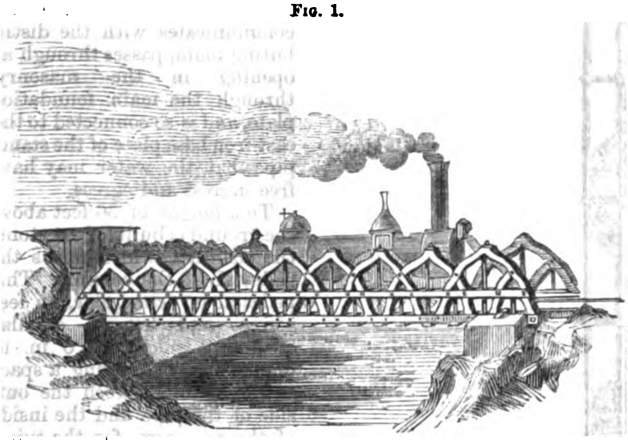


Fig. 2.

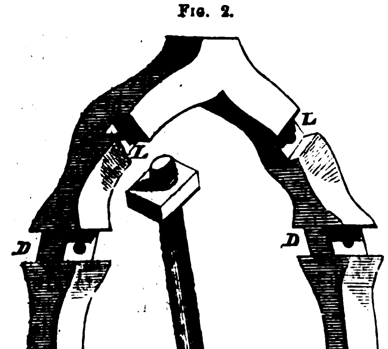



Fig. 3.

Fig. 1 represents a perspective view of the truss as applied to a railroad bridge; fig. 2 is a view of one of the gothic-arch braces detached; and fig. 3 represents two of the vertical rods with their straining blocks, their nuts and screws, the longer one extending from the bottom of the lower chords to the top of the gothic-arch braces, and the shorter one extends from the bottom of the lower chords to the top of the upper ones. The same letters refer to like parts. Each two of the gothic-arch braces are locked together at L, and secured by screw bolts. The lower chords of the bridge are applied to the tenons and shoulders P, P, at the bottom of the gothic-arch braces—one on each side, and secured thereto by bolts. The upper chords of the bridge are applied to the daps and shoulders at D, near the middle of the braces, and are secured by bolts. The longer rods E, pass through straining blocks beneath the lower chords, or through straining cross-beams beneath them, and extend upwards between the chords and through the top of the gothic-arch braces, where they are secured by nuts and screws. The shorter rods F, pass through straining blocks beneath the lower chords, extend upwards, and are secured at the top of the upper chords by straining blocks, nuts, and screws.

The advantages of this truss over others of a different construction are stated to be, first, "that it is not so liable to be affected by expansion and contraction from heat and cold; second, not liable to be increased in length by cambering; third, there is no thrust strain on the chords, but the greater the pressure on the truss, the nearer the parts are brought together, and the closer becomes the joints; fourth, every piece supports a part of the whole structure, and there is no dead-weight of iron or useless material."

* From the 'Scientific American.'

## TRACES OF MODERN ARCHITECTURE AND ART IN RUSSIA.

The first traces of the introduction of modern art in Russia are due to the Grand Duke of Russia, Ivan III. Wassiljewitsch, who reigned from 1462 to 1505. When he intended to erect, in 1473, a splendid church of the Ascension of the Virgin, in Moscow, he obtained from Plescow a person who had been instructed by German masons, and sent to Italy to obtain an able architect at any cost. Such a one was found in the person of a Greek of the name of Aristoteles, who had been previously employed by Mohammed II., at Constantinople, in the building of a palace, and at Venice had erected a splendid portal and a church. His wages were two pounds of silver (then ten roubles) a month, and he was the person who introduced the new Italian style into Russia, where before only the Byzantine-Gothic had been cultivated. Ivan III. also built for himself the first stone mansion, whereas all former Grand Dukes had lived in wooden houses. It was called the Hewn Palace (*granatowitaja palata*), and it was intended to be used on festive occasions, for the reception of ambassadors, &c. The latter, however, was built by an Italian architect, called Marco the Italian, who had for his assistant another of his countrymen, named Peter Antonio, who built the house during the period from 1487 to 1491. Another palace, built on the Jaroslaw Place, was burnt in the great fire of 1493. Ivan III. caused the erection of a more extensive building by the Milanese architect Aloysio, which was called Dworez Teremnyi, and is yet standing. He also surrounded the Kremlin with splendid walls and turrets. The whole fortress was surrounded by high and strong walls and ditches, and for obtaining an open space around it, houses and even churches were demolished. He sent also to Italy for silversmiths and founders. The latter established the first cannon foundry in Moscow in 1488, and also cast bells. To them, also, belonged the architect Aristoteles, whose name is to be found on Russian coins of that time. It was by Greek, Italian, and German artists that the first coins were struck in Russia, who had been brought thither by Ivan's wife, Sophia, and it was in her honour that the first gold coin was struck in Moscow in 1497.

For the sake of encouraging the opening of mines, and as the Russians were not able to drive shafts, Ivan availed himself of the amity of Mathias Corvinus, of Hungary, and obtained miners and engineers from thence, as well as from the Emperor of Germany, Maximilian I., and was constantly endeavouring to entice architects to his kingdom, for the erection of new palaces, churches, and entire towns — tendencies which again exploded during the reign of his ignorant and sanguinary successors.

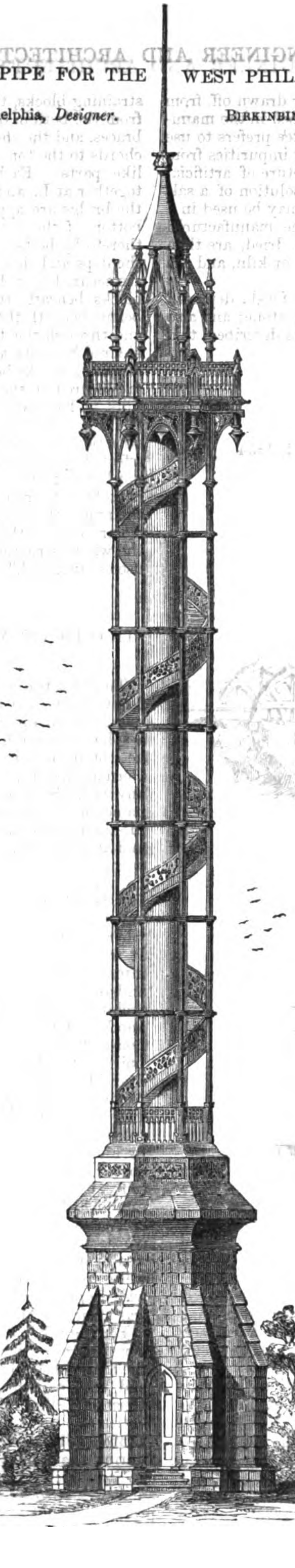
# ORNAMENTAL STAND-PIPE FOR THE WEST PHILADELPHIA WATERWORKS.

H. Howson, C.E., Philadelphia, *Designer*. Birkinbine and Trotter, *Contractors*.

Perhaps no city in the world is more profusely supplied with wholesome water than Philadelphia. Since the completion of the justly celebrated waterworks at Fairmount, what might formerly be termed the suburbs of Philadelphia have increased so rapidly and extensively, that it has been found necessary to construct additional works to supply the increased demand. Philadelphia, which, by a recent act of consolidation, now comprises both the old city proper and all the surrounding districts, is now plentifully furnished with water from three large works, namely, those of Fairmount, Spring Garden, and Kensington; the two former receiving their water from the river Schuylkill, and the latter from the Delaware.

On the banks of the Schuylkill, and directly opposite the old city, is the district of West Philadelphia, now also incorporated with the new consolidated city. This district has, on account of its elevated and healthy position, as well as its proximity to the business portion of the city, become a favourite locality with the mercantile and wealthier portion of the community. Its situation, too, with regard to the river, particularly adapts it to the establishment of manufactories, which of late years have rapidly accumulated.

To obtain an efficient supply of water for this flourishing district from the works already established on the opposite banks of the river, would have been attended with considerable difficulties; the enterprising commissioners therefore determined to erect substantial works on the spot. It was deemed advisable, in order to procure a sufficient head of water, to make use of a standpipe similar to that at the East London Waterworks. A plain pipe, however, erected in so elevated and prominent a position, would evidently have been a great eyesore to the whole neighbourhood. To obviate this, Messrs. Birkinbine and Trotter, to whom the contract for the whole works was awarded, proposed to erect a tower which should combine the two qualities of utility and ornament. With this object in view, these gentlemen applied to Mr. H. Howson, who furnished them with the original design and working drawings from which the structure of which we give an illustration was built.



The central portion of the tower, which comprises the pipe or tank into which the water is forced, is 5 feet in diameter and 130 feet high, and is made of plate-iron varying in thickness from $\frac{5}{8}$-inch at the bottom to $\frac{1}{2}$-inch at the top. The bottom of the pipe is riveted to a circular flanch on a thick cast-iron base plate, which is secured by substantial bolts and keys to the main foundation plate. The latter rests on a foundation of heavy masonry, to which it is permanently attached by strong anchor-bolts. A branch pipe, 12 inches in diameter, which communicates with the distributing main, passes through an opening in the masonry, through the main foundation plate, and is so connected to the cast-iron base plate of the stand-pipe that the water may have free ingress and egress.

To a height of 36 feet above the ground is built (of cut stone) the masonry, which forms the pedestal of the column. This pedestal is octangular, 15 feet across, and has a circular opening inside 9 ft. 6 in. in diameter, thus leaving a space of 2 ft. 3 in. between the outside of the pipe and the inside of the masonry, for the spiral stairs. Radiating from the centre of the pipe, and passing across this space at suitable intervals, are a number of wrought-iron bars which (one end being bolted to the pipe and the other let into the stonework) serve the double purpose of connecting the ironwork and masonry together, and act as supports for the cast-iron steps. At each of the eight corners of the pedestal are built buttresses 24 inches thick, and 22 feet measuring diagonally across the corners of the pedestal. The projecting cornice at the upper portion of the masonry is 20 feet across; above this, and into each of the eight sides, are let cast-iron panels ornamented with Gothic tracery. Access is obtained to the interior of the pedestal through a Gothic doorway, 8 feet high and 3 feet wide.

Screwed to the top of the masonry by means of strong anchor-bolts, are eight cast-iron plates firmly tied together so as to form a ring. To these plates are attached iron pedestals, which are connected together by Gothic railings, and which support the eight rows of cluster columns; the latter being carried upwards in lengths of 10 feet, form the exterior of the shaft. Rings of cast-iron, into which the ends of the cluster columns are packed, serve to keep them at the required distance from each other. Spiral winding pieces, also of cast-iron, are bolted to the outside of the pipe, and similar winding pieces to the inside of the cluster columns; both have a number of flanches projecting from their sides, to which the steps are separately bolted. To the exterior winding piece, and between the cluster columns, are secured a series of castings, which are so carved as to represent a continuous Gothic scroll railing. These pieces are further confined to their places by a suitable hand-rail, which is also bolted to the inside of the columns.

It will be seen that the spiral winding pieces and hand-rails, secured in this manner, serve as diagonal braces for the cluster columns. The stairway terminates at an octangular landing 17 feet across, which is composed of plates laid on radiating cast-iron beams, one end of the latter being fastened to the pipe, and the other to the corners of the entablature, and the whole further supported by the cluster columns and ornamental brackets securely bolted to both the columns and the entablature. Surrounding the platform or landing is a Gothic railing, of the same pattern as that already referred to.

The cluster columns are carried upwards through the platform, above which they are connected together by arched pieces, and to the pipe by flying buttresses, and terminate in suitable pinnacles. To the top of the pipe, or rather to the top of cast-iron pilasters attached to the pipe, is secured the plate-iron spire 9 ft. 6 in. high, surmounted with a flag staff.

The whole height of the tower from the ground to the top of the spire is 140 feet, and to the landing 114 ft. 8 in., the latter being reached by a flight of 172 steps. This altitude, together with the fact of the whole structure being erected on one of the most elevated points in the neighbourhood, will afford from the platform a prospect of the most extensive and varied description.

The engines of the West Philadephia Waterworks, which will be completed in the autumn of this year, are on the direct-action Cornish principle, and are furnished with Birkinbine's patent supplementary-valve apparatus (see *Journal, ante* p. 148), together with a modified and simple valve gearing arranged by Mr. Howson, of Stockton House, Philadelphia, the designer of the Stand-Pipe.

## ON THE MOTION OF WATER THROUGH PIPES.*

By Henry Hennessy, M.R.I.A.

A very elaborate series of experiments have been recently made at Paris, on the motion of water through pipes, by M. Darcy, director of the public waterworks of that city. A memoir detailing the methods of experiment, and the results obtained, having been submitted to the Academy of Sciences, a commission of inquiry was appointed, from which has emanated an extremely valuable report, drawn up by M. Morin, and published in the number of the Comptes Rendus which has been just received.

The utility of economising and properly regulating the supply of water to towns and manufactories, is now so fully recognised —the industrial and social importance of any practical conclusions that may be drawn from well-conducted hydraulic experiments, so completely admitted—that it appears desirable to give the utmost publicity to these investigations.

The experimental and mathematical researches which have hitherto formed the basis for engineering calculations, have generally afforded but little information as to the influence of the condition of the interior surfaces of the pipes on the resistance to the flow of water. Partly resulting from this cause is the fact not unfrequently observed in connection with great water works, that while the volume of water actually discharged through new cast-iron pipes is generally greater than that deduced from scientific rules, as soon as the pipes have been some time in use, and that deposits have been formed in them, the state of things is entirely reversed.

One of the chief objects of M. Darcy's investigations being to clear up practical difficulties of this kind, he proceeded to make a series of experiments, in order to determine—

1. The influences of the state of the surfaces on the discharge.
2. The influence of the diameters of the pipes on the resistance.

He used pipes varying in diameter from the smallest ever used for practical purposes, to half a metre, or a little more than 1 ft. 7½ in. The pipes were also of different materials, some of drawn iron or lead, and some of iron coated with pitch, or of smooth glass, also cast-iron pipes, some of them quite new, some old with deposits, and some old without deposits.

The experimental arrangements were such that the observer was able to measure the pressure or effectual head of water in the iron pipes at the origin of movement and at distances of 50 and 100 metres [164 and 328 feet] farther on. The difference would give the measure of the loss occasioned by the resistance of the surfaces.

The leaden pipes, which were 50 metres long, or more than twelve hundred times the diameter of the thickest employed, had the pressures measured at a distance of 25 metres. A similar arrangement was made in the glass tubes, which had nearly the same dimensions. The mean velocities obtained in these experiments varied from 0·03 metres to 5 or 6 metres per second; that is, from 1·18 inch to 16 ft. 5 in., or 19 ft. 8½ in. nearly, thus going even beyond the limits used in practice. The inclinations and diameters of the several pipes were carefully measured by the most approved methods.

The most important general result deduced from these experiments is, that the nature and state of the interior of the pipes exercise a considerable influence on the discharge.

It appears, for example, that compared with the formulæ of M. Prony, iron pipes coated with pitch give discharges greater than the calculated results in the proportion of nearly 4 to 3; that glass gives similar results; but that in cast-iron pipes, whose diameter had been only very slightly diminished by deposits, the velocities, and therefore the effective discharges, were decidedly less than the theoretical indications, while after a thorough scouring a perfect agreement became manifest.

The diameters of the pipes seemed also to exercise a more decided influence on the discharge than what had been hitherto assigned to them; for with small diameters the results were less than by the formulæ, while they were greater for large diameters. This influence of the diameters was probably overlooked, as suggested by M. Darcy, from the fortuitous compensation established between the resistance in very thin but smooth pipes, and those of considerable thickness but encumbered by deposits.

From a discussion of his experimental results, it follows that the law of resistance is generally expressed by the usual formula:

$$v^2 B + v A = R I$$

R being the mean radius or hydraulic mean depth, I the inclination of the tube due to the resistance, $v$ the velocity of efflux, and A and B constants. But an exception to this law holds in the case of very thin tubes and low velocities, in which case the term B disappears, and the resistance is proportioned to the velocity simply. As might be expected, therefore, the diameter and the substances composing the different pipes have been found to influence the values of A and B, for these have been found to differ in tubes of the same dimensions but of different degrees of internal smoothness, and also in those which were equally smooth but with unequal radii.

In pipes containing much deposited matter, which is usual in those that have been some time in service, it appears from M. Darcy's experiments that the resistance (as admitted by several engineers) could be safely considered as simply proportional to the square of the velocity, thus simplifying practical calculations. These experiments being made with pressures so varied and so considerable, an admirable opportunity was afforded for testing the long-admitted principle, that the resistance presented by the sides of a tube to the liquid passing through is independent of the pressure of that liquid. It was found, for example, that where the head of water varied in the ratio of from about 55 ft. 9 in. to 85 ft. 4 in., and again from about 72 feet to 131 feet, between the two parts of the pipe submitted to observation, the differences or losses of head have remained the same for both parts. Such decisive results completely comfirm the important hydraulic principle just mentioned.

In order to determine the numerical values of the constants A and B in the formula

$$v^2 B + v A = R I,$$

M. Morin objects very properly to the use of the method of least squares, as not only requiring very troublesome calculations, but also introducing into the results the influence of mere accidental anomalies, which such experiments sometimes present. He prefers a graphical representation of the actual results of experi-

* From the 'Dublin Monthly Journal of Industrial Progress.'

ment, as being more expeditious, and capable of rendering more palpable such accidental circumstances as may deviate from the usual law. M. Darcy has employed this method simultaneously with that of least squares, and has thus in a great measure obviated the imperfections of the latter. Observers in every department of physical science might profit by the hint of M. Morin as to the successive employment of the two methods, by which, we presume, he means the application, first of the graphical method, so as to detect the accidental anomalies, and then, on their elimination, the application of the method of least squares to the purified results.

After determining the values of the constant coefficients for tubes of different materials and dimensions, M. Darcy has estimated, by the aid of his formulæ, the velocities corresponding to the different inclinations, and has compared them with the observed velocities. This comparison shows, that for all kinds of pipes, and for every diameter, as soon as the velocities attain a few décimètres,* the formula of resistance may be changed to

$$v^2 B_1 = R I,$$

and this will be especially correct for pipes containing deposits; that is, for working pipes in their usual condition.

A comparison of the values obtained for the coefficient which determines the resistance in tubes differing but slightly in thickness, has shown that their different degrees of smoothness, and general condition of their internal surfaces, exercise very remarkable effects on the amount of that resistance. Thus, tubes of thin sheet-iron coated with pitch, of clean cast-iron, and of cast-iron covered with deposits, each having in inches respectively the diameters, 7·717, 7·401, and 9·567, gave for $B_1$ values which varied proportionally from 1 to 1·5 and 3. This result shows, that in estimating the action of a series of pipes for water-works, they should be always supposed to have arrived at the normal condition of being coated with more or less deposit, no matter how comparatively smooth they may be at the time of laying them down.

Having found by experiment that the resistance diminishes with an increase of diameter, M. Darcy sought the law of variation as some simple function of the diameter, and he has shown that $B_1$ in the formula last given, may be represented by two terms, one constant, and the other varying inversely with the diameter of the tube. The law thus becomes

$$R I = v^2 \left(a + \frac{b}{R}\right)$$

Or if L represent the length of the pipe and H the height due to the resistance,

$$H = v^2 \frac{L}{R} \left(a + \frac{b}{R}\right).$$

From a series of eight experiments with tubes of drawn and cast-iron, sensibly of the same degree of smoothness, and with diameters varying from half a metre down to 0·122 metre M. Darcy has obtained the following numerical values:—

$$a = \cdot0000507, \quad b = \cdot00000647.$$

When the values of R, L, and $v$ are given in English feet—

$$a = \cdot0000507, \quad b = \cdot00002122.$$

The expression generally recognised among hydraulic engineers as equivalent to the foregoing, is given by Mr. Neville in the form,†

$$R I = v^2 \left(a + \frac{b}{v^{\frac{1}{2}}}\right)$$

Where

$$a = \cdot00005585, \quad b = \cdot00006859.$$

On making use of these results a very satisfactory agreement was found with observation, so that it was possible to safely calculate the values of $B_1$ in the formula of $v^2 B_1 = R I$, for all diameters, for every centimetre from the first up to 50, or half a metre, and also for every 5 centimetres up to a metre. By simple transformations of the preceding formulæ, which will readily occur to scientific readers, it is possible to obtain rules for calculating the inclination required for obtaining a given velocity with a certain diameter of pipe, or the converse problem of finding the velocity corresponding to a given inclination.

The variation of the coefficient of resistance, which must be taken into account for narrow pipes, is much less perceptible in those with diameters greater than from about 5 to 6 inches, and it may be considered, without inconvenience, as constant for all those of greater diameter.

M. Darcy has also turned his attention to another question connected with the motion of fluids in pipes, which, although comparatively unimportant for practical purposes, possesses much scientific interest. The point referred to is the law of variation of velocity of the particles of fluid from the axis of a pipe where it is a maximum, to the surface where it is a minimum. With the aid of a small and very slender Pitot tube, of which one branch could be placed parallel to the axis of the pipe at different distances from that axis, and of a manometer giving the pressure exercised on the surface, he has determined the excess of pressure observed at the Pitot tube over that on the manometer, and by a special process, the velocity of the fluid acting on this tube, or some quantity proportional to the velocity. Comparing in this way, for different inclinations, the excess of velocities in the axis over the velocities at different distances therefrom with the square roots of the inclinations, it followed:—

1. That the ratio of this excess to the inclinations was constant.

2. That the ratio of this excess to the $\frac{3}{2}$ power of the distance of a moving particle from the axis was constant for the same inclination.

3. That the ratio K of the same excess to the product $r^{\frac{3}{2}} \sqrt{I}$, constant for the same pipe, varies from one pipe to another inversely as the radius, so that $\frac{K}{R}$ is constant.

It is hence easy to infer that the relation between the velocity V, of the particles situated in the axis of a pipe, with the velocity $v$, of those situated at a distance $r$, from the axis, is represented by

$$V - v = \frac{K r^{\frac{3}{2}} \sqrt{I}}{R}$$

Whence, if $w$ represent the velocity of a particle at the surface of the pipe,

$$w = V - K \sqrt{R I}; \quad \text{or, } K \sqrt{I} = \frac{V - w}{\sqrt{R}}$$

Whence substituting, we obtain,

$$v = V - (V - w) \frac{r}{R} \sqrt{\frac{r}{R}}$$

From which the velocity of any particle may be obtained if the velocities in the axis and at the surface are known.

It finally appears that for the mean velocity $u$, M. Darcy has deduced the expression,

$$u = \frac{3v + 4w}{7}.$$

By comparing the results of experiments made with different pipes, M. Darcy has been led to conclude, that although the degree of smoothness of the interior of a pipe must influence the resistance, and consequently the mean velocity of the fluid, it does not affect the law of variation of velocities from the axis to the surface, which appears to depend on the viscosity or molecular condition of the liquid.

It seems that the conclusions at which M. Darcy has arrived relative to the coefficient of contraction have not been considered quite satisfactory. It appears from the theory established by M. Poncelet, that the coefficient in question is a function of that at the opening of the tube, which varies with the head of water, the dimensions of the orifices, and the velocity. It follows, therefore, that the coefficient of contraction at the origin of the pipes ought itself to vary with these quantities; but M. Darcy has obtained a constant coefficient, such as is generally admitted, and this only by a compensation of differences. We have very little doubt that a more correct result would have been obtained if he had employed in the discussion of his experiments, the graphical method in the peculiar way to which attention has been already directed.

Here we must conclude our account of these important researches, which we are glad to learn will be publised in detail by the Academy of Sciences, in the 'Mémoires des Savants Etrangers.'

* One décimètre = 3·93708 inches, not much less than 4 inches.

† See 'Hydraulic Tables, Coefficients, and Formulæ,' by John Neville, C.E., M.R.I.A., County Surveyor of Louth.

## THE USE OF COAL IN LOCOMOTIVE ENGINES.

REPORT *of* Messrs. WOODS *and* MARSHALL *to the London and North-Western Railway Company, on the Burning of Coal in Locomotive Engines.*

Under the following resolution of the general locomotive committee of the 9th July, we have made a series of experiments on some of the engines of the southern division, with a view to report to you upon the questions submitted to us:

"Resolved,—That Messrs. Woods and Marshall be instructed to make trial of the various sorts of coal in the engines of the southern division, and to report to the next meeting of this committee whether coal can be efficiently and satisfactorily used, in what proportion, and at what cost, as compared with coke."

After conferring with Mr. M'Connell, and with a view to completing our report within the specified time, we judged it expedient to limit our experiments to the trial of two kinds of coal, and to a comparison of the performances of an engine of the class known as Mr. M'Connell's patent, with those of an engine of the "Bloomer" class.

The Hawksbury coal seemed to be most eligible for use on the southern division; on account of its being procurable at a comparatively low price, in consequence of the proximity of the pits to the main line of the southern division.

The pits are situate on the Coventry and Nuneaton branch, about four miles from Coventry, and yield a coal of hard quality, free from any excess of bituminous matter; and, in other respects (as, for instance, in freedom from clinker) favourable for combustion in engine furnaces.

Two qualities of this coal have been submitted by us to trial, viz:—Main coal, which is delivered in large blocks free from small coal, and the coal termed "screenings," or "cobbles," which is delivered in small lumps, but free from dust or slack. The prices, as given to us by Mr. M'Connell, are—

Main coal, delivered in contractor's wagons at Rugby .................. 9*s.* 7½*d.* per ton.
Cobbles, ditto........................... 7*s.* 8¼*d.* ditto.

The cobbles are not so hard as the main coal, and break into smaller fragments when struck by the hammer.

The cobbles can only be supplied in limited quantity.

For the purpose of comparison of the cost of working, it was important to obtain the exact duty of the engine with coke as well as with coal, and our series, therefore, includes the results of several days' work with the best coke we could obtain—viz., Pease's West coke.

The engine worked alternate days with coke and coal, performing each day 164¼ miles, the double journey between Rugby and London.

The performances of the first two days are not here recorded, and may be considered as preliminary. The weather on one of these days was very stormy, and rendered the results of an exceptional character; and the men had not then acquired the knowledge of the management of a coal fire, which a little further experience gave them.

For six consecutive days (the Sunday excepted) the passenger engine No. 303, Mr. M'Connell's patent, worked the 12·55 p.m. up express train, and the 5·45 p.m. down train, three days with Pease's West coke, and three with the Hawksbury main coal; these two trains being nearly equal in weight, and presenting little variation during the period.

The details of these, and the subsequent experiments, will be found in the table appended, but the following are the general results:—

*No.* 303 *Engine.*

| Series. | Description of Fuel. | Miles run. | Average Load Carriages. | Average Speed per Hour. | Fuel consumed per mile. | Water Evaporated per lb. fuel. |
|---|---|---|---|---|---|---|
| | | | | Miles. | lb. | lb. |
| A | Coke ...... | 492¾ | 14·1 | 31·62 | 25·34 | 8·59 |
| B | Coal ...... | 492¾ | 13·2 | 33·26 | 35·59 | 5·78 |

Deeming it necessary to ascertain the practicability of using coal with heavier trains, we caused the same engine, No. 303, to work the 6·30 a.m. down train and the 11·46 a.m. up train over the same ground. We had one day's experiment with coke, one day with Hawksbury Main coal, and one day with cobbles. The following are the results:—

*No.* 303 *Engine.*

| Series. | Description of Fuel. | Miles run. | Average Load Carriages. | Average Speed per Hour. | Fuel consumed per mile. | Water Evaporated per lb. fuel. |
|---|---|---|---|---|---|---|
| | | | | Miles. | lb. | lb. |
| C | Coke ...... | 164¼ | 19·2 | 29·41 | 26·80 | 8·82 |
| D | Main coal | 164¼ | 20·6 | 28·96 | 41·66 | 5·86 |
| E | Cobbles ... | 164¼ | 29·3 | 27·76 | 51·49 | 5·97 |

The remaining experiment we have to record is with one of the largest class of the ordinary engines, No. 293, working the 12·55 p.m. up, and 5·45 p.m. down trains, with Hawksbury Main coal. The engine has a large fire-box with a longitudinal midfeather and two fire-doors.

*No.* 293 *Engine.*

| Series. | Description of Fuel. | Miles run. | Average Load Carriages. | Average Speed per Hour. | Fuel consumed per mile. | Water Evaporated per lb. fuel. |
|---|---|---|---|---|---|---|
| | | | | Miles. | lb. | lb. |
| F | Main coal | 164¼ | 14·1 | 32·96 | 47·75 | 4·52 |

I. The question of the practicability of burning coal in such locomotives must be answered in the affirmative. The engines had no difficulty in maintaining the required pressure of steam and speed with the trains assigned to them.

II. Taking a general view of all the performances of the engine No. 303 with coal, the consumption, or rather non-production of smoke, was very completely attained.

In the majority of cases, both in travelling and standing, the engine was practically free from smoke, the trace being so slight as to be imperceptible without close examination, and we did not observe in any instance that the smoke emitted could be accounted a nuisance.

From these remarks we of course exclude the period of lighting the fire and getting up the steam, when the combustion is incomplete, and the production of smoke cannot be avoided.

The non-production of smoke, whilst the engine is working, no doubt depends very much upon the individual skill and care of the engineman and fireman, and demand very close and watchful attention on their parts.

The conditions under which the results related were obtained are as follows:—

1. Working with a very thin fire on a large area of grate, and with fire-bars laid much closer together than is necessary for coke. By the large area of grate and thin fire, a large volume of air is enabled to pass through the ignited fuel under a moderate draught.

2. Frequent firing in small quantities to equalise the disengagement of the gases, and thereby prevent the production of a larger quantity at one time than can be saturated by the air passing through a grate or fire-door. This frequency of firing involves much greater care and labour on the part of the fireman. It was found in the trials, that, on an average, the fireman fired four or five times more frequently with a coal than with a coke fire. Say once in every two or three miles, instead of once in 10 or 12 miles.

In throwing on the fuel the fireman has carefully to observe the state of the fire, that he may throw the fresh coal so as to maintain a uniform covering of the grate; the thickness of fuel ranged from about 4 to 6 inches.

3. *Alternate Firing.*—The fire-box, divided longitudinally by midfeather into two separate compartments, each provided with a fire-door, gives the means of firing alternately, and thus keeping a bright fire in one box, whilst the other is damped by the addition of black coal.

4. The combustion chamber allows of the mixture of the gaseous products of the two fires with the quantity of free oxygen needful to effect their due saturation, affording space for combustion to take place before the gases pass into the tubes. This arrangement, combined with the double box, renders Mr. M'Connell's engine a more perfect "smoke-consumer" than the common engine.

5. *Quality of the Coal.*—The coals were in lumps of moderate size, to prevent obstruction to the draught, and sudden generation of a large volume of gas, which ensues upon throwing small coal or dust into a bright fire. Hardness in the coal is a quality which tends to diminish the proportion of dust from breakage. The coal should contain as little bituminous matter as may be, and burn with little ash or clinker.

6. Damper, to regulate admission of air to the grate, must be capable of being closed, wholly or partially, otherwise smoke will be emitted, and fuel wasted at the stations.

It must be understood that the above were the conditions observed, and apparently required, in working the engine No. 303 efficiently and satisfactorily with coal; but we do not assert that these are invariable conditions as applicable to other engines, the different construction of which might adapt them to burn coal in another way.

The experiment with No. 293 engine did not give so good a result in point of smoke burning; a brownish tint of smoke was pretty constantly observable, but though sometimes very light, was frequently decidedly objectionable.

On the other hand, it is fair to state that the man who drove it had not had much experience in burning coal, which, as may be inferred from our foregoing remarks, requires a management of the fire altogether different from that of a coke fire.

We believe, however, that general experience shows that the ordinary engine is not well adapted for smoke burning, and it is certain that in the case of No. 293, the smoke-box became overheated by a large accumulation of coal-dust partly ignited.

These effects were altogether absent in No. 303 engine, owing, doubtless, to the large receptacle in front of the tubes, which served to arrest and detain in the fire-box the smaller particles of coal which otherwise would have passed through the tubes.

III. Relative powers of coke and coal.

The comparison of series A with series B indicates a consumption of coal 40 per cent. greater than that of coke in working similar trains, the average loads and speeds being nearly the same; but the work, as indicated by the consumption of water, being slightly less on the occasions when coal was used.

The comparison of series C and D, with a heavier and slower description of train, gives a consumption of coal 55 per cent. greater than with coke.

Taking the quantity of water as probably the most correct approximate measure of the several resistances, we find the mean duties to be as follows:—

1 lb. coke to 8·65 lb. water; | 1 lb. coal to 5·83 lb. water;

which show a proportion of 100 lb. coke as equivalent to 148 lb. coal, as consumed in No. 303 engine.

We shall, therefore, assume 48 per cent. increase in estimating the relative cost of coal as compared with coke.

The more imperfect performance of No. 293 engine gives a much greater difference, being no less than 90 per cent.

The consumption of coke observed in these experiments accords very closely with the results of the experiments made under similar circumstances, and detailed in our former reports.

From the great excess in the quantity of coal consumed over coke, we are strongly disposed to think there must be something disadvantageous in the construction of the above engines, or in the mode of working them, as regards their applicability for the use of coal as a fuel.

This view is confirmed by the results of some experiments made at Wolverton, in the fixed-engine boiler there, with the same qualities of coal and coke, wherein the difference of heating or evaporative power appears to be only 20 per cent., the evaporation being 7·99 lb. of water per lb. of coke, and 6·77 lb. of ditto per lb. of coal.

IV. Relative economy in cost of fuel.

The price of the Hawksbury Main coal being assumed at 9*s*. 7½*d*. per ton, and the price of Pease's West coke at 21*s*. 9*d*. per ton, which is the contract price for the same delivered at Rugby in the contractor's wagons, we may estimate that the cost of a quantity of coal, equivalent to one ton of coke, will be 14*s*. 3*d*., being 9*s*. 7½*d*. increased by 48 per cent.

Out of the 21*s*. 9*d*. paid for the above coke, we are informed that your Company receive back from the Midland Railway Company, under a special agreement, an allowance of 9*d*. per ton. This reduces the cost to Company to 21*s*. per ton.

The saving by use of coal would then be 6*s*. 9*d*. per ton, or the difference between 21*s*. and 14*s*. 3*d*.

Upon an annual total consumption of, say 74,000 tons on the southern division, the saving to locomotive power would be 24,975*l*. from this cause.

This, however, assumes that all the engines are of a kind suitable for burning coal, and that no other fuel is used.

As far as our present experience goes, the large engines of the No. 303 class are the only engines on the line in which coal can be practically used without occasioning a nuisance, and these constitute at present but a small proportion of the entire stock.

The expediency of increasing the stock of such engines, for the purpose of effecting, wholly or partially, the saving in cost of fuel which we have indicated, is a question which your Directors will probably not consider within our province at present to discuss, involving as it does so many collateral considerations; also having reference to the general economy of the Company's expenditure—such as cost of engines and the general working expenses.

If the question be entertained as a general one for the whole line, the additional weight of fuel to be transported from place to place—whether in the wagons or on the tenders—and the additional number of hands necessary for emptying the wagons and distributing the coal, will occasion expenses which we have not taken into account.

Although we consider the experiments made with No. 303 engine satisfactory in point of smoke burning, we cannot resist the belief that the consumption of coal is in excess of what it ought to be, and that there is room for considerable improvement in this respect by means which shall tend to utilise the heat which is at present wasted.

## THE TWO TUNNEL SEWERS FOR THE ARTERIAL DRAINAGE OF THE METROPOLIS.

TO THE RIGHT HON. VISCOUNT PALMERSTON, G.C.B., M.P.

MY LORD—I have been duly honoured with the acknowledgement of the receipt of my printed letter on the subject of the Great London Drainage Plan.

Seventy millions of gallons of water are daily raised to the surface of a densely-inhabited valley, and there converted into sewage, stagnating in the low-lying districts of the metropolis, and, daily polluting the atmosphere and the Thames, they urgently demand an efficient outfall.

The Metropolitan Commission of Sewers do not propose the removal of the injury resulting to the inhabitants, but to spend 1,050,000*l*. in covering over a naturally-formed rivulet, meandering through open fields, "the Hackney Brook," and in diverting similar rural drainage into the populous locality of Deptford.

These works have been strongly opposed by public meetings and circulars, by deputations to the Home Office and Greek-street, and also by petitions to Parliament; and it is respectfully submitted that no money should be devoted to their construction.

The Great London Drainage Plan of two tunnel sewers running through the most populous localities, extending from Chelsea and Vauxhall respectively to the marshes east of the metropolis, would be capable of removing not only 70 millions, but 270 millions of gallons of sewage daily, and would cost 1,000,000*l*.

These tunnel sewers were very favourably entertained by the government in 1845-6; were approved by the officers of the Westminster Improvement and Commission of Sewers in 1847; were not opposed by a resolution of the City Commission, February 29, 1848; and subsequently received assurance of support, March 21, 1848; their comprehensive character being acknowledged by the Metropolitan Commission, by resolutions, March 7, 1848, by report to Parliament, February 24, 1851, and by the resignation of the Commissioners when they were unable to carry them into execution, June 23, 1852.

This plan rests upon actual surveys and levels, confirmed estimates, borings, and data collected during a series of years. Its having been prosecuted through the agency of Commercial enterprise, as the only means available to private individuals, and its having been twice submitted to the scrutiny of a Select Committee, is respectfully urged in its behalf.

Your lordship directed the attention of the House to this arterial drainage of the metropolis on the 4th and 9th March, 1853, and subsequently.

S. S. MOREWOOD.

*Islington, July 21st, 1854.*

## HINTS ON THE NEW STEAM FRIGATES FOR THE UNITED STATES.*

By J. M. Roebling, C.E., Niagara.

It is announced that Chief Engineer Martin is going to Europe to examine naval machinery, with a view of introducing useful improvements in the construction of the new steam frigates ordered to be built. This move appears to indicate a determination on the part of our naval authorities to produce something excellent, and to do justice to the progressive spirit of the age. The following remarks are respectfully submitted to the consideration of those who will be charged with the planning of the machinery and boilers.

The great success of the Collins' steamers appears to be principally owing to the great evaporative power of the boilers, and to the excellent model of the hull—two points in which the Cunard steamers are inferior. The general plan of engines is the same in both lines, and I believe the expansive action of steam is made use of to nearly the same extent. Nor is there a material difference in the pressure of steam carried; the consumption of coal of the Cunard line I have not been able to ascertain. The power of the *Arctic*, with 95-inch cylinders, 10 feet stroke, cut-off at 4 ft. 4 in., 30 lb. pressure in the boiler, 28 lb. in the cylinders, 4 lb. vacuum, 14 revolutions per minute, may be rated at 1645 effective horse-power, one horse-power equal to 33,000 lb. raised one foot per minute. The average speed of this vessel during six voyages, according to Mr. Isherwood, was $12\frac{4}{10}$ miles (statute), consumption of coal per voyage 946 tons, and per hour 7980 lb. This makes the consumption of 1-horse power per hour 4·85 lb. really a very creditable result. The average evaporative power of the boiler is stated at $7\frac{1}{2}$ lb. of water of 110° by 1 lb. of anthracite. Looking at these facts, there appears to be left but little room for improvements in the way of efficiency and economy. And this is the opinion of many professional men, *such* men as would never have achieved the above results had *they* been the performers.

It is to be regretted that the old clumsy mode of feeding sea-water was adopted in the Collins' line, while such an excellent apparatus as Pirsson's Condenser could have been applied. This condenser is bound to work if properly constructed. Here, then, is one opening for a very essential and highly important improvement in our new steam frigates.

I shall now suggest another, but promise nothing new; I only desire to draw attention to the old, well-established, and well-known fact of the great economy produced by the expansive action of steam. I wish to see the principle of the Cornish engine successfully carried out in these new frigates. I propose to carry steam of 60 lb. pressure, or say 45 lb. above the atmosphere in place of $15\frac{1}{2}$ lb., the practice of the Collins' line, and to cut-off at one-eighth part of the stroke in place of half-stroke. And in order to produce a *uniform* rotary motion, and to keep down the size of cylinders, I propose three cylinders in place of two, to work three cranks set at an angle of 120°, in place of two cranks set at an angle of 90°. This plan contemplates a radical change in the old mode of construction; it may appear rash and venturesome to the timid and to the *let-good-enough-alone*. But nothing short of a radical change in the plan of engines and boilers will produce a *material* advance upon the great success of the Collins' steamers. I do not discuss the model, because I am not a competent judge on that point. Steam-engines and boilers are my province, where I may venture an opinion. I feel satisfied that, aside from the model, the above plan, if well carried out, will, in connection with my new boilers, bring steam navigation to perfection at once. I flatter myself that this opinion will be concurred in by all those who will candidly examine the question, and who have made themselves competent by study and experience. It is only recently that the Cornish engine has attracted much attention outside of the small district where it has been an established fact for many years. The astonishing labour so economically performed by that great pumping-engine which is draining the Haarlem Lake in Holland has been the result of expansion.

The rule for calculating the effect of expansive action is, divide the length of stroke by the length of the cut-off, the hyperbolic logarithm of that quotient, added to 1, will represent the effect of the whole expansive action, the force of the full stroke at full pressure being represented by the quotient. I propose to cut-off at one-eighth part of the stroke. Now let us examine the relative effect of the expansive action at one-half, one-quarter and one-eighth of the stroke:—

| | |
|---|---|
| The hyperbolic logarithm of 2 is | 0·693 |
| " " 4 is | 1·386 |
| " " 8 is | 2·079 |
| This gives the effect of half-stroke | 1·693 |
| The full stroke being represented by | 2·000000 |
| The effect of quarter stroke is | 2·386 |
| " full stroke being | 4·000000 |
| " cutting off at one-eighth | 3·079 |
| " full stroke being | 8·000000 |
| Now let us represent the effect of full stroke with full pressure by | 1·000000 |
| The effect of half-stroke will be | 0·846 |
| " quarter stroke | 0·596 |
| " cut off at one-eighth | 0·385 |
| And also, if one ton of coal at full stroke produces an effect represented by | 1·000000 |
| Ditto cutting off at one-half | 1·690 |
| Ditto " one-quarter | 2·386 |
| Ditto " one-eighth | 3·079 |
| And further, if a voyage to Liverpool, using steam without expansion, will consume | 1200 tons |
| The consumption at half-stroke will be | 700 tons |
| " quarter-stroke | 500 tons |
| " one-eighth stroke | 400 tons |

In round numbers, therefore, by cutting off at one-eighth part of the stroke, we will make this voyage with 400 tons, while we should consume 500 tons at quarter-stroke, 700 tons at half-stroke, and 1200 tons at whole-stroke. Here, then, is a wide field open—very wide indeed! I hazard very little when I predict, that in less than ten years our voyage to Liverpool in vessels of 3000 tons burthen will be made inside of ten days, and with less than 400 tons of good anthracite coal, and this will be achieved alone by expansive action, by three cylinders, and by my superior mode of combustion and generating steam, independent of improvements which may result from greater capacity and superior model, and perhaps a superior mode of propulsion.

The above figures show the theoretical effect of expansion, which of course will suffer a reduction in practice. Short stroke comparatively, say not exceeding 10 feet, but wide cylinders, well encased by three or four layers of felt, which will keep them warm, and prevent the reduction of the expanded steam, will bring us nearer to the theoretical result. But the whole of that result can be made good by a superior combustion and evaporation.

The application of three cylinders and three cranks will insure a more uniform rotary motion than is now obtained by two cylinders cutting off at half stroke.

Objections will be raised, on the score of safety, to carrying steam of 45 lb. above the atmosphere. These, however, can be fully answered. I should prefer a higher pressure, if the great increase in the weight of the boiler would not balance, to some extent, the increased economy resulting from the use of higher steam. The difficulty of securing tight joints and preventing leakage and waste is also another weighty argument against high-pressure, such as 100 lb. and more. As regards safety, if we take a common-sense and practical view of the matter, it will certainly be plain enough to every person, that if I provide a strength three times the ordinary allowance for sea-boilers carrying 13 lb. above the atmosphere, I shall be just as safe carrying 45 lb. pressure above the atmosphere. But can this be done, and safely and well? No one will deny it who is a practical worker in iron, and who is at all familiar with steam-boilers. Our steam-boat men in the West laugh at the idea of 45 lb. being called high-pressure. They have frequent explosions, and are altogether reckless in the management of steam; but there are also to be found intelligent and careful men who are conscious of the great danger, and who keep within the bounds of safety. The packets on the Ohio river have uniformly carried, before the new law came in force, 180 lb. per square inch upon the safety-valve in boilers of 42 inches diameter, of $\frac{1}{4}$-inch iron, when new. This is equivalent to an absolute force of 15,120 lb. per square inch section of iron, or scarcely one-third of the ultimate strength of good boiler iron, allowing for riveting. The contemplation of this fact, when travelling on those boats is well calculated to

* From the 'Scientific American.'

cause a little uneasiness. The fact that boilers made of good iron and well managed have run on the Ohio river for years, without accident, only shows how much good iron may be depended on. In marine boilers a very large allowance of strength is absolutely necessary; none but the best material should be used, and double riveted throughout.

If great power and economy are all important in a commercial steamer, they are still more so in a vessel of war. Long cruises cannot be undertaken with a propelling apparatus that wastes the fuel; strict economy is of paramount importance, In ordinary running, expansive action should be made use of to the fullest extent; the fuel should be saved to enable the vessel to keep the sea or to meet a superior enemy and beat him successfully. In place of cutting off at one-eighth of the stroke, cut off at half stroke in time of an action, this will more than double the power. The boilers, of course, should have capacity enough to keep up a supply of steam for a short time. A few rapid movements, which will give the steamer a decided advantage over his slow-moving enemy, may decide the whole action.

In case of an accident to one of the engines, the chances are in favour of three cylinders. The damaged one can be thrown out of gear, while the voyage is continued with the other two cylinders, which will give a more uniform motion than one single cylinder.

The cylinders of the *Arctic* have 95-inch bore and 10-feet stroke; this makes the area of the piston 7088 superficial inches, and the pressure at 19 lb. mean pressure per inch 134,672 lb., and the momentum of a 10-feet stroke 1,346,720 lb. Assuming the pressure of 52 lb. effective per inch, we find the momentum of one superficial inch of piston, acting at full pressure throughout the stroke of 10 feet, $52 \times 10 = 520$. To produce the effect of one of the *Arctic's* cylinders, an area of piston will be needed equal to $1,346,720 \div 520 = 2667$ superficial inches. And in order to cut off at one-eighth of the stroke, the enlarged size of the piston will be found $2667 : x :: 0·385 : 1000$, or $x = 6927$ superficial inches. Or a piston of 6927 superficial inches, equal to 94 inch diameter, carrying 52 lb. effective pressure at the commencement of stroke, and cutting off at one-eighth of the stroke, will produce the same effect, theoretically, as a cylinder of 95 inches diameter, with a pressure of 28 lb. at the commencement of the stroke, and cutting off at 4 ft. 4 in.

Using three cylinders in place of two, we shall find the required size of the pistons to be $6927 \div \frac{3}{2} = 4618$ superficial inches, or $76\frac{3}{4}$ inches diameter and 10 feet stroke. The strength of cylinders and balance of machinery must be increased over that of the *Arctic* to meet the greater pressure of the steam when admitted.

## ON MARINE BOILERS.*

By J. A. Roebling, C.E., Niagara.

The furnace of a boiler should be so constructed as to render combustion as perfect as possible, but it can do no more than produce carbonic acid. If only one-half of the oxygen necessary to form carbonic acid combines with carbon, the result will be carbonic oxide, a product of imperfect combustion. A certain supply of atmospheric air, therefore, is necessary. But this supply may be too copious or too scant, it may enter the furnace too rapidly or too slow, but it cannot be too high for rapid combustion. It is also evident that the quality of the fuel must have a controlling influence upon these various conditions. Wood as fuel for marine boilers is out of the question; we can only consider mineral coals—anthracite and bituminous—as fit for ocean steaming. It is not my intention here to analyse these varieties; I only notice them in so far as their peculiar qualities require peculiar mechanical arrangements for good combustion.

Soft or bituminous coal requires more time to be consumed, economically, than hard coal. The large bulk of hydrogenic and bituminous compounds, mixed up with floating particles of carbon, which result from the burning of soft coal, require to be thoroughly mixed with heated air before perfect combustion can take place. The mechanical arrangements to effect this are of great importance, but may be overlooked when hard or anthracite coal is consumed. This fuel admits of a much more rapid consumption and of a powerful blast, while the draught of a soft coal furnace should not be very strong.

Experience has not yet settled the most economical speed of consumption of mineral coals. Watt's rule was to allow one superficial foot of grate surface for every ten superficial feet of heating surface, and this rule produces good results with natural draught. The boilers of the Collins' steamers are undoubtedly the most efficient and best constructed boilers now in use either here or in Europe. According to Mr. Isherwood, those of the *Arctic* contain 0·357 feet of grate for 11·84 feet of heating surface for every effective horse-power, or 33 feet of heating surface for 1 foot of grate.

According to the same author, whose account of the performance of the *Arctic*, published in the 'Journal of the Franklin Institute,' appears to be reliable, the average consumption of anthracite during six trips was 7980 lb. per hour. The aggregate grate surface of the four boilers of that steamer is 588 feet, which gives 13·57 lb. of coal per hour for each foot of grate. In boilers of ordinary construction with natural draught, half the weight of soft coal would be a fair consumption.

Chemists who have examined the evaporative power of various fuels agree that 1 lb. of good mineral coal, perfectly consumed, will evaporate over 11 lb. of boiling water. Experiments on a larger scale will seldom evaporate more than 9 lb. to 10 lb. The boilers of the *Arctic*, during those six trips, evaporated $7\frac{1}{2}$ lb. of steam from water of 110° by 1 lb. of anthracite, and this is one of the highest results that has been obtained in the regular working of marine boilers. It is evident therefore, that there is room left for improvements. There is still a waste of fuel in the Collins' steamers, which arises from imperfect combustion, the result in part of a faulty construction, and no doubt in part is attributable to imperfect stoking. Much of course depends upon the mode of firing, nor is it always practicable, to carry on this important part of the service according to the best rules.

In attempting to improve the construction of boilers, we may receive good hints from an examination of the condition and working of other furnaces, in which good combustion and a high degree of heat are important objects. Furnaces used in the manufacture of iron, such as blast, puddling, heating, and annealing furnaces, may be referred to.

Perfect combustion can only take place under such circumstances as are favourable to the development of intense flame and heat. Aside from the necessary quantity of air supplied at a certain rule, and heated if possible, there are other contingencies upon which success depends; a very important one is the nature of the material which surrounds the furnace, forms its walls and roof, and comes into immediate contact with the fire. The question, then, at once arises, can the process of combustion be successfully carried on in a narrow furnace, surrounded by iron walls and roof, in contact with water, which absorbs the heat at a rapid rate? Most certainly not. Who would undertake to heat and puddle iron in a furnace built of iron plate in contact with water? Iron water-boshes are sometimes resorted to, but they have a tendency to retard the process, and should be avoided if possible. Such furnaces are constructed of good fire-brick, which is a slow-absorbing and slow-conducting material, and after being glazed over by the strong heat will strongly reflect it. By this strong reflection and non-absorption, the process of combustion is supported in an eminent degree, so much so, that a degree of heat is obtained far exceeding the temperature of any boiler furnace. As little heat as possible should be absorbed by the walls or roof of a boiler furnace; every endeavour should be made to reflect and concentrate the fire. Imperfect combustion in any furnace most generally arises from the fact that the heat is not allowed to accumulate and concentrate. The sole object of a boiler furnace should be to favour combustion, and to develope flame and blaze, and this can only be accomplished under the influence of a highly concentrated and excited action. The caloric stream thus fully elaborated, on leaving the furnace is then allowed to expand itself, and to be absorbed by the interior surface of the boiler.

I may remark here, by way of general comment upon furnaces for heating houses, that the whole tribe of *Patent Furnaces* with which the country is blessed, have all, more or less, grown out of erroneous notions, and are the offspring of profound ignorance of the laws of combustion and of heat. Aside from the vitiated air they supply, they are all wasting fuel at an enormous rate. This subject is better understood in the north of Europe, where long winters and scarcity of fuel have taught men to build furnaces on correct principles.

The temperature of a puddling or heating furnace has to be raised to about 3000°; this can only be accomplished under the reflecting and reverberatory action of the walls and roof. A con-

* From the 'Scientific American.'

centrated blast may produce a greater heat at a certain point, but it will not be diffused. Under the above circumstances, and by means of a strong blast, from three to four times as much fuel may be consumed on the same surface of grate in one unit of time as can be accomplished in a common boiler furnace. In a well-constructed heating furnace at my rolling-mill at Trenton, N. J., 8000 lb. of anthracite are consumed in ten hours for the heating of 18,000 lb. of charcoal hammered blooms, on a grate of 20 superficial feet, which is equivalent to 40 lb. per hour on 1 foot of grate. This cannot be accomplished in the furnaces of the Collins' steamers, which consume 13½ lb. per hour on 1 foot of grate.

In the above a principle is delineated, which to my knowledge has been entirely overlooked, and which must be satisfied before we can attain much higher results.

Another glaring defect in all marine boilers, those of the Collins' steamers not excepted, is the want of room necessary for a due mixing of the gases, and a full development of the blaze.

Large quantities of fuel in a narrow and low furnace cannot be consumed without waste. In order to become fully excited and most positive in its action, the blaze of a fire must be at liberty to extend and elongate in the direction of the draught to a distance corresponding to its bulk, and without meeting absorbing obstructions. For illustration I again refer to heating and puddling furnaces. This fact can be readily ascertained in an experimental furnace with adjustable roof. The brightest fire will burn under the highest roof, while the depressing action of a low roof will damp it and reduce the temperature of the furnace.

Economy of space is an important consideration in the planning of a marine boiler, but this may be carried so far as to seriously interfere with the grand object of the boiler. In an efficient boiler, the extension of the furnace should form an empty area, which serves as a receptacle for the caloric stream where the gases become thoroughly mixed and fully ignited before their caloric is expended upon the boiler surface. And for the purpose of allowing ample time to the heat to be absorbed by the tubes, the above space, together with the tube area, should be as large as possible. The arrangement must be so, that the draught between the furnace and the chimney should be very slow, so that all the caloric, or nearly all, may be absorbed before the unconsumed gases are allowed to escape.

The boilers of the *Arctic* have 33 feet of heating surface for 1 foot of grate surface; this allowance is scarcely enough for hard coal—40 to 1 will not prove an excess. But this proportion depends in a great measure upon the velocity of the draught through the area which contains the tube or heating surface. The larger this space, or the longer its extent, the slower the motion of the gases will be, or the more extended their travel, consequently the longer they will remain in contact with the tubes. It is a very general defect in marine boilers that the draught from the furnace to the chimney through the tube area, or through the flues, is nearly uniform, and too rapid. The "hanging-sheets" in the boilers of the Collins' steamers were designed to arrest this rapid flow, but they are not sufficient. The fact is, that the common plan of flue or tube boilers does not admit of a thorough application of the important principle in question, hence the necessity of a radical change.

Other questions of importance have to be considered in the planning of a marine boiler. Strength, facility of construction, and repairs, provisions against unequal contraction and expansion, against incrustation, facility of blowing out, and of cleaning, safety against exposure of heating surface when the ship is rolling or careening; all these are important points, but more or less understood. By the above remarks, I have only attempted to direct attention to such points as are not generally understood, and consequently neglected. In a new plan of boilers which I have invented, all the essential conditions of perfect combustion, radiation, and absorption are fulfilled, and is calculated to produce much higher results than have been obtained heretofore.

In conclusion, I will yet remark, that the subject of *artificial* draught is in a great measure an open question yet. The common fan-blast will answer very well under certain conditions, but in marine boilers, I am satisfied, *exhaustion* by proper mechanical means will work better. The control of large and connected fires can be better maintained by *exhaustion* than by *blast*, and also more economically.

## LOCKING STONES IN FOUNDATIONS OF LIGHT-HOUSES.*

JOHN P. AVERY, *Patentee*, U.S., April 25, 1854.

FIG. 1.

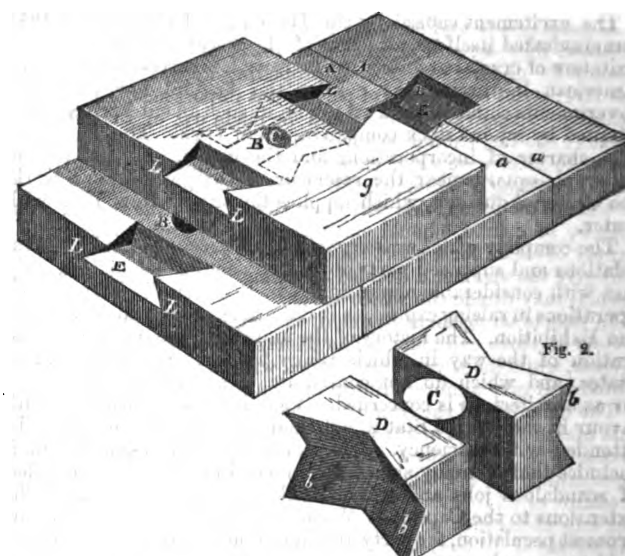


Fig. 2.

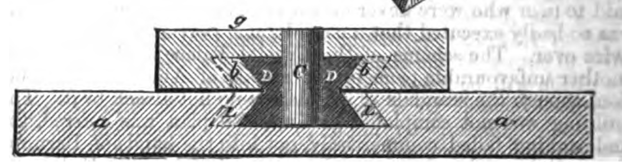


FIG. 3.

FIG. 1 is a perspective view of this system of locking stones, showing one stone placed upon two others, and the whole locked together—the dotted lines showing the form of the dovetails. Fig 2 is a perspective view showing the dovetails or locks, and the manner in which they are forced apart, when it is desired to lock the stones together; and fig. 3 is a vertical section showing three stones locked together—two below and one above. The same letters refer to like parts.

*a, a, a*, represent the bottom stones of a foundation, for instance, in which dovetail slots E, E, E, of a suitable depth are cut, or half that of the dovetails; the said slots being open on the sides which are placed opposite each other, and made wider at their bottom than at their top, thereby forming an inclined projecting lip L, under which the flanges *b, b*, of the dovetails D, D, fit snugly when the key G, is driven between the dovetails. In figs. 1 and 3 a stone *g*, is represented placed on top of the foundation stones *a, a*, and the whole secured together; this stone has a slot E, similar to those in A, A, cut in its bottom surface, and of the same depth as half the height of the dovetails. Thus it will be seen that when these stones are put together, the dovetails will hold equally on each as they fit the same depth in one as in the other. After these dovetails have been placed in the bottom slots, the top stone is placed over them and caused to fit in its slot E. After this is done, the key *c*, or its equivalent, which passes through the hole B, in the top stone, is driven between them, and they are forced apart, which causes their flanges to fit snugly and securely under the inclined projecting lip L, L. By this arrangement of the double-wedge flanged dovetails, constructed as described, and uniting the two adjoining stones in the lower course with the stone which breaks joint with them in the upper course, the stones in the two courses are neatly and expeditiously fitted together, the specified flange-form of the dovetails, when the key is driven home, serving most effectually to draw the stones in the two courses together, face to face, thus making tight the horizonal joint between the courses, and simultaneously making tight the vertical or end joint, as specified, so that the two courses are made expeditiously to become one solid mass, as it were, the flanged dovetails acting as clamps to keep the two courses together.

* From the 'Scientific American.'

## REVIEWS.

*New York Crystal Palace: Illustrated Description of the Building.* By GEORGE CARSTENSEN and CHARLES GILDEMEISTER, Architects. New York: Riker, Thorne, and Co. 1854.

The excitement caused by the Hyde-park Exhibition of 1851 communicated itself to all parts of the world, and among other imitators of crystal architecture, more or less successful, were our American brethren. As neither the Federal nor the State governments could be induced to join in such an enterprise, it was adopted by a joint stock company in New York. The State gave it a charter of incorporation, and the city gave it an area in Reservoir-square, near the reservoir of that well-known work, the Croton Aqueduct, which supplies the city of New York with water.

The company which was organised, on account of the political relations and supposed party objects of some of its founders, early met with considerable opposition, which materially cramped its operations in raising capital, as it did afterwards in the conduct of the Exhibition. The history of the undertaking is a curious illustration of the way in which affairs are managed in the United States, and which do not contribute to satisfactory results, so far as architecture is concerned. Vast designs readily meet with favour in the United States, but their execution is not sure to be attended with efficiency. The history of railways, although it includes that of many successful undertakings, yet includes that of scandalous jobs and virtual robberies. The building of the extensions to the Capitol at Washington was attended with the grossest peculation, for party and individual purposes; wages were paid to men who were never on the spot, and even what was done was so badly executed that a considerable portion had to be done twice over. The scheme of the Crystal Palace at New York is another unfavourable page in the annals of American construction, though the scandals of peculation do not attach to it. The building was not completed in time, the plan was marred, the undertaking failed commercially, got into the hands of Barnum, the notorious showman, and is at length sold up. It did not, however, want for the encouragement and support of those in authority. The President opened it in state, though he and his suite got a ducking for their pains, and the English government sent one of the most pretentious missions which has yet reached the shores of the Atlantic. Many of the local and colonial authorities gave their countenance, and the contributions were of a remarkable character. Upon these, reports have been drawn up by the English commissioners, and which have been duly published. In fact, all that the co-operation of Prince Albert could do for the Exhibition was done, with the view of inducing the public on both sides of the water to look upon him as the originator of these exhibitions, and a patron of the useful arts.

The design for the New York Palace was obtained from Messrs. Carstensen and Gildemeister, foreigners, and a great part of the staff engaged in the construction were foreigners. Although the design of the two architects was adopted, and they superintended with a large foreign staff under them, the chief control was in what was called the building department, under Mr. C. E. Detmold, a Hamburgher, but several of whose assistants were native citizens. The surveyors were of foreign origin. The result of the independent organisation, and of the undertaking being intrusted to foreigners, was that, as usual among Germans, they quarrelled among themselves, and Messrs. Carstensen and Gildemeister, the authors of the chronicle of the Palace, lay the blame on Herr Detmold, while Herr Detmold and his party charge it upon the architects, and the committee lay it upon both. It is clear enough, from what we have in the book, that the constructing department and the engineering department did not agree, and there was no want of occasions on which they could express their dissatisfaction with each other. As to the amount of personal blame to be apportioned to either party, we do not think it worth while to consider; the fault lay in the original vice of the organisation, under which such dissension and disagreement was almost inevitable, as few men could have worked harmoniously together under such circumstances, particularly Germans. And further, the committee had not matured their scheme in the first instance. They had not measured their resources; and they went on, from hand to mouth—Yankee fashion—cutting, scheming, and contriving, what is called going-a-head, but really going through a variety of shifts; under which all unity of design, all grandeur of design, all completeness of effect, were sure to be marred, as they have been. The architects endeavoured, in the first instance, to provide sufficient space and a complete design, but the committee directed them to cut down the estimates; while again, at a future period, they were told to provide space, which they could only do by resorting to a make-shift. Then the contracts were let after the same fashion; and as the price of iron rose in the meanwhile, the contractors declined to complete their contracts, and the work was protracted from want of materials. The history of these difficulties and squabbles is a long one; and from all we have heard, the architects have only given us their side, and it is only of interest as showing how these things are managed elsewhere, and that we have little chance of improvement by taking a leaf out of the transatlantic book. In railway making we have learned something, and we are about to apply it usefully in India, for it is an advantage to begin on a small scale, and work on as the traffic increases; but this very system becomes an evil when, as we have said, a great and uniform design is in contemplation.

Messrs. Carstensen and Gildemeister have settled as architects in New York. They furnished the design chiefly with the purpose of showing their abilities and obtaining distinction; they worked for costs out of pocket, receiving not more than eight thousand dollars; and they have published this book partly to explain their work, and partly to vindicate their reputation. The technical part of the book will be read with attention, for the design is meritorious, and the authors bestowed great care in the completion of the works. It contains, likewise, all the plates of details which are necessary for its illustration. It is another of those works which are most creditable to the United States. The work will receive the notice of our professional men for the further reason that the building was executed at a moderate cost under considerable difficulties.

With regard to the origin of the work, the authors give the following account:—

"A charter having been granted by the Legislature of New York, incorporating an Association for the Exhibition of the Industry of all Nations, a committee having been organised, and a lease of Reservoir-square at a nominal rent having been procured from the city government, it was announced that the furnishing of a design for the contemplated building was open to competition. The circumstance of our becoming competitors was purely accidental. We did not know of the lists being open until about three weeks before the final arrangement, when, at the suggestion of our friends, we undertook the task of furnishing the design worthy of the occasion. Previous to the acceptance of our plan by the Board of Directors, the latter entertained exceedingly restricted ideas regarding the limits of the future enterprise. The company was limited in its means; both at home and abroad a feeling of distrust was manifested towards what was considered to be a private speculation rather than a national undertaking, and European states were cautious in giving any promises of co-operation. The committee, therefore, thought it advisable to restrict their expenditure for the edifice to the sum of 175,000 dollars, and to content themselves with a one story building, which should embrace as much as possible of the ground allotted to them on Reservoir-square. If the reader refers to our correspondence with the Board on this subject it will be seen that we foresaw and stated the necessity of providing more space than that originally contemplated. As illustration of the correctness of our views may be found in the fact that although the building designed by us contained (in the shape of galleries) 62,000 square feet more than they imagined would be required, it was found necessary to erect an extra building, in order to contain a machine-arcade and picture gallery, at the sacrifice of much important time; at the risk of serious injury to the symmetry of the principal edifice. In the accompanying illustrations which we furnish of various modifications of our original design made to suit the need of the company, it will be observed that we at first proposed a basement story, which, if carried out, would have given an additional surface of 150,000 square feet, for about the same sum as was afterwards expended on the erection of the somewhat unsightly machine arcade. The prudence of the Board of Directors went even so far in point of economy as to suggest the abolition of galleries altogether. Independently of the artistic incompleteness which would have pervaded an entirely naked shed, such as the Palace would have become had this suggestion been adopted, those who visited the Exhibition after its opening, and observed the crowded effect of many of its departments, will at once perceive how very inadequate the building would have been to meet its practical purpose without those galleries. Had our original plan been adopted in its totality, some serious defects that now exist would have been entirely avoided. The presence of a basement story would have elevated the building about six feet, thus decreasing the unfavourable effect which the heavy masonry of the Reservoir now now produces upon it. But so depressed was the feeling of some members of the Executive, that it was at two different periods suggested to have, instead of a lofty and aerial dome which should give dignity and elegance to the whole structure, an open court in the centre, roofed in with canvas. Even the unprofessional reader can easily realise the effect of so flat and ungainly an edifice, when so closely contrasted with the huge proportions of the Reservoir.

Our plan having met with the approbation of the Board of Directors, and these alterations having been carried out which the smallness of capital of the company rendered unavoidable, our contract was signed on the 26th August, 1852, after which the mechanical departments were called into action. The contracts for the masonry were given out on the 4th of September, and on the 25th of the same month the iron work was contracted for. It was stipulated that the foundation should be ready, and the first necessary castings delivered on the 21st of October. A pattern shop was established in this city, under the superintendence of Messrs. C. J. Shepard and John Purvis, and the contracts for iron were distributed amongst various manufacturers, some in New York City and State; others in New Jersey, Pennsylvania, Delaware, and Connecticut. This distribution of the iron contracts, owing to the failure in making arrangements for the whole supply from any one or two houses in the city, was the occasion afterwards of much inconvenience and disappointment, as will be shown in the course of our statement."

The writers again refer to the pattern shop. They say:

"With regard to those duties which were strictly ours, we do not hesitate to assert that they were punctually performed. If anybody has a right to complain it is ourselves, who on almost every occasion experienced considerable difficulties in getting our designs practically carried out with quickness.

Immediately after the idea of the Crystal Palace was matured, a pattern shop was established expressly for making the necessary patterns for the iron castings to be used in the building. This establishment was abundantly provided with mechanics, and it became of course a matter of economical necessity to keep them continually supplied with designs from which to construct their patterns for the cast-iron work. In obedience to this necessity we furnished these drawings so rapidly that numbers of them remained undisposed of for some weeks and months, either because the workmen were over supplied, or from some defect in the system on which the establishment was conducted. The effect of this arrangement was, however, soon seriously felt. The undivided attention which was given to the cast-iron work interfered so much with the progress of the wrought-iron work, that it was almost entirely laid aside, and although constituting a very essential part of the building, such as the dome, the trusses supporting the same, the roofs, galleries, staircases, &c., it was almost entirely neglected at a period when it should have commanded the principal attention of the superintending engineer.

One of the chief causes of the delays so frequently complained of was the dilatoriness with which the iron materials for the building were delivered. Shortly after the contracts were made the prices of iron were increased, and the contractors appeared unwilling to purchase and deliver at a higher rate than they themselves were to receive according to the terms of their contract. Not having been entrusted by the Board of Directors with the contracting department, we took no part in the giving out of contracts, and had no power to enforce their fulfilment. By the short-coming of contractors and failure of the Executive to hold them to their obligations, we were reduced to the most lamentable expedients to get materials together; we had to search from store to store for angle iron, making what use we best could of such pieces as we were able to procure in this desultory manner, completely reversing the usual order of such matters, and constructing our building with reference to the materials, instead of getting those which would suit our construction. As a signal and eloquent instance of the want of system which pervaded the entire working corps, we may state that the castings for the second story of the building were delivered on the ground a considerable time before those required for the first story were even ready."

The result of all these shortcomings is, that the building has been left in a most incomplete state. The leakage of the roof is one defect, and the condition of the paneling is another:

"Shortly after the palace became roofed, the leakage which occurred was a matter of serious inconvenience and annoyance. If the reader will refer to that part of our technical description which regards the gutters and louvres, he will find that we furnished designs and made suggestions for those parts of the building, which, had they been adopted, would undoubtedly have precluded such a result as leakage. Another plan for gutters, was however, put into execution, suggested by other parties. The end obtained by this alteration from the original plan did not prove to be quite so satisfactory as the directors had anticipated.

In regard to the awnings placed over the louvres to prevent the leakage through them, we object to them for the following reasons;—1. That they spoil the appearance of the building, and prevent proper ventilation. 2. That they have cost too much in time and expense. 3. That they did not fulfil their purpose, which was proved by the first heavy shower. Besides, we feel convinced that after becoming decayed, they will be torn into shreds, and thus injure the appearance of the building.

Most of the outside panels are made of sheet instead of cast-iron, for which latter material we had furnished the necessary drawings, and several patterns as well as castings had been executed accordingly; but as they were considered too heavy and expensive by the superintending engineer, we consented to the substitution with the express understanding that the ornamental mouldings should be affixed to them, which has not been done, giving those panels over the different roofs, and below the cornice of the dome, a rather plain, and, in some instances, a deformed appearance."

Upon the interesting subject of the decoration of the interior, the same want of co-operation was manifested; and the architects have strong ground for complaint that their original design was abandoned, and that they were not consulted on the plan adopted. On this head they strengthen themselves by an appeal to the views of Mr. W. J. Hayter Lewis, the architect of the Panopticon, as expressed by him before the Royal Institute of British Architects. Messrs. Carstensen and Gildemeister observe—

"We cannot omit here to remark that the unsightly appearance of the stoves, with their pipes carried through the whole height of the building, which are employed by the Executive for heating the same, would have been avoided if necessary provisions according to our suggestions had been made in proper time. Nor have we had any part whatever in the distribution of space, or in the decorations of the different departments with their contents. We have only directed the exhibition of Thorwaldsen's statues of *Our Saviour and the Twelve Apostles*, with the baptismal font, which was one of the few departments entirely completed at the opening of the exhibition.

For the decoration of the dome we had devised two designs, besides the one described in the letter in the Appendix. The first was for the ground, a rich blue with gilt or silver stars in relief. The second was as follows:—From the apex of the dome a cluster of silver rays were to radiate down to about a third of its depth, giving the effect of light bursting in through an aperture above. The remaining two-thirds of the dome were to have been coloured in alternate subdued red and white stripes, over which a network was stretched, giving the effect of a huge American ensign having been cast over the dome, and supported in its place by the ribs and the network which would seem to bulge and droop beneath the superincumbent weight. Without wishing to insist upon the superiority of either of these designs over the one adopted, and executed by Mr. Monte Lilla, under the superintendence of Mr. Greenough, we cannot refrain from adverting to the defects of the latter, where the apex or receding point of the dome was painted yellow, which is the most advancing colour in the spectrum, and the base or nearest point a light blue, which is the colour always used to bestow the effect of a receding object. The consequence was that the dome lost a third of its apparent size by this distribution of colours. The yellow brings the top nearer to the spectators, while the blue gives to the base the effect of distance, and the vault which should have looked light, aerial, and expansive, has now been flattened down. We at one time understood that a gentleman from England, Mr. Mould, a pupil of Mr. Owen Jones, offered some meritorious designs for the decoration of the building, which were not accepted. We had not the pleasure to see these designs until seven months after the Crystal Palace was opened, but we think that in a matter so important as the decoration of a building which we designed, it was the duty of the Executive to permit us to have a voice in the affair; a just courtesy which was never granted. On the whole we trust that the reader, after a perusal of this statement, and the accompanying correspondence, will see that whatever mistakes may have occured during the erection, and in the completion of the Crystal Palace, they are not attributable to us."

The details of their design for the decoration are given in an address to the Board:

"Outside the building a lively olive bronze colour, for panels, columns, arches, girders, cornices, towers, &c. The projecting parts of the mouldings to be kept with a lighter shade, and on some of the receding parts; with a darker shade of the same standard colour.

The heads and brackets on the window arches, ornaments over cornice, tower railings, &c., to be gilt; or painted with a colour substituted for gilding.

The window-frames and bars to be painted with a very dark green bronze colour, so as to relieve the shade of the glass. A specimen of this mode of decoration has been executed under our direction, on a section towards the north-west part of the building.

The roof of the lean-tos, aisles, nave, and dome, to be painted with copper-green, or lead colour. The projecting ribs of the dome to be gilt, or receive a colour capable of being substituted for gilding.

All the louvres with a warm straw colour. The outside railings with a greenish bronze colour. Lamp posts and lamps relieved with slight gilding, or a substitute for the same.

Inside of the building.—Columns, girders, arches, &c., with a warm yellow colour, relieved with stripes of a rich deep blue, and red and white. Base pieces, capitals, brackets, mouldings, and other ornaments painted with positive colours, and gilding according to principles existing for moresque decorations. The construction of the roofs, as standards, braces, rafters, purlins, ribs, tie-rods, trusses, &c., with a deep orange colour, relieved, when necessary, with a deep red colour. The ceiling of the lean-tos, aisles, nave, and dome to be painted with white, red, and blue colours, on canvas, forming panels between the intersections of the said purlins, rafters, &c. This part of the decoration should be kept very lively and airy, principally on the dome, as the lightness of the construction will not suffer any heavy looking covering. The borders of those panels should not be too broad, or too complicated in their designs, as the first will not look well, and the last will occupy too long a time in executing; a tasteful and noble simplicity should be the general characteristic of the decoration. For this reason, we should object to the under part of the gallery floors being varnished, as they will appear entirely too heavy and dark, in the immediate vicinity of the lively colours of the girders, and lean-to ceilings—a white colour with a slight tint of either blue or pink, with deep blue or red stripes on the chamfering of beams, &c., would produce, according to our ideas, a much more harmonising and finished effect. The railings of galleries, stairs, &c., to be painted white and varnished; the standards, eagles, and rosettes to be relieved by gilding. Also, for a part of this inside decoration a specimen has been executed, under our direction, in a part of the north-west lean-to. In conclusion, we beg leave to add, that the above mentioned style of decoration is kept in accordance with the tinted designs of the outside and inside perspective views of the building, which we had the honour to present to the Board, when we submitted our plan in competition with others; the only modification made being the bronze colour for the outside, which we found the necessity of, in perceiving the dark green shade thrown by the glass on the whole building, and which materially deteriorates its general effect."

The objections to M. Monte Lilla's treatment of the dome, we believe to be well founded; but the adoption of bronze colour for external details is open to controversy, for a correspondent of the *Athenæum*—probably one of the Great Exhibition officials—in speaking of the Bavarian Crystal Palace, just opened at Munich, says the bronze on the exterior is a complete failure, inasmuch as it deadens it, and materially diminishes the otherwise light effect of glass and iron. It is to be observed, however, that the New York architects advocate a light bronze colour,—what they call a lively olive bronze; but it is questionable whether this would not be too decided, though in that building less glass has been used. It is strange that a sculptor—Mr. Greenough—was the chief director of the colouring.

The general description of the building at New York is as follows:—

"The materials used in the construction are mainly iron and glass,—wood only being employed in the floors, doors, and sashes. The central part is surmounted by the dome 71 feet from the floor to the spring of the arch, which rests on 24 columns, 16 of which form two concentric regular octagons, the one inscribed within, the other circumscribed outside a circle of 100 diameter; the distance of the columns in the latter, 41 ft. 5 in., thus determines the width of four naves, radiating from the centre, and carried up to a height of 67 feet from the ground floor to the ridge of the roof. On each side of the naves the aisles extend to the same length, each 54 feet from the first floor to the highest point of the ceiling. The naves with the aisles form in this manner a Greek cross, over the centre of which the dome rises, and the spaces in the exterior angles of the cross are fitted up with triangular lean-tos, one story 24 feet high, giving to the ground plan on the first floor the form of a nearly regular octagon, at each angle of which an octagonal tower of 8 feet diameter rises to a height of 71 feet.

The whole space thus inclosed, with the exception of the central part under the dome, and the 4 naves, is divided, by columns 27 feet apart from their centres, into square and triangular compartments or bays. On three sides of the building project entrance halls corresponding in width with the naves, and 27 feet deep, with offices attached to each side, 27 feet wide by 18 feet deep, and are subdivided into two stories, the upper ones being accessible from the platform of the adjoining staircases in the main building. The fourth side, situated towards the Croton Reservoir, is left without an entrance.

The second story extends over the aisles, and over two bays of each nave, thus forming an uninterrupted gallery of 54 feet width around the whole building, and accessible from all parts of the structure by 12 large staircases, 4 of which are placed under the dome, and 8 at the ends of the aisles near the entrance halls; 8 winding stairs in the towers facilitate the communication between both stories for the officers of the association.

Three large balconies over the entrance halls and offices are approached from the galleries. The building presents three pricipal fronts to the three streets which inclose it, the architecture of which is sufficiently shown in the accompanying plates.

After the original plan had been adopted, and the structure commenced, it was found necessary to furnish additional space, for which purpose the machine arcade was attached to the eastern side of the building. The space between the latter and the Croton Reservoir was thereby nearly filled up, a narrow passage of 5 feet width only being left according to the requisition of the Croton department. The length of this arcade is 451 ft. 5 in., its greatest width 75 feet, and that of the two story building 21 feet; the first story is partly of the same height as in the main building, the lower parts or sheds are from 13 ft. 4 in. to 16 ft. 4 in. high, and the second story which connects with the galleries of the main building, and forms a picture gallery, with a skylight extending almost its entire length, is 18 ft. 9 in. high without the skylight, which rises 5 ft. 6 in. higher."

With regard to the wrought-iron girders, it is observed:

"Some of these girders, after being put into their places, showed some defects in their lower flange and the diagonals, after the floors were tested with a weight of 85 lb. to the square foot. In consequence of this, tie-rods extending from the top of the second story columns were employed to relieve the standards nearest to the columns, which produce a very bad effect to the eye, although the same security might have been attained by ordinary inverted trusses under the floor, such as were placed according to our advice under four of these girders by Mr. Kroehl, the assistant engineer."

The raising of the dome was thus accomplished:

"The lantern was completed on the ground, and raised between two poles, about 10 feet higher than the required height of the dome. Four derricks were then placed on the bed-plate of the dome, by which the ribs, brought to the spot, on account of their length, in three different pieces each, were, after having been riveted together on the ground, hoisted to their places, bolted and keyed to the bed-plate, and bolted to their shoes in the upper ring, supporting the lantern. When this was done, and the braces adjusted, the lantern was disconnected from the poles, which were then removed. The contractors for raising the building deserve great credit for their skill in raising the dome, which was accomplished in four and a half working days; much is also due to the contractors for the ironwork, the assistant engineer superintending the whole construction and erection of it, and last but not least, to the efficient body of mechanics who, in sunshine and storm, applied themselves steadily to their labours."

Although the details of the Hyde Park Palace were closely studied, and full advantage was taken of the experience and the labours of Messrs. Fox and Henderson, as is duly acknowledged, the New York architects introduced many modifications. One was as to the arrangements for sweeping:

"All the floors are calculated to be laid with tongued and grooved boards, and to receive a number of small moveable reservoirs, or caissons, 2 or 3 feet in diameter, covered by cast-iron perforated rosettes, to answer the purposes of cleanliness. In the London Crystal Palace, the planks of the floors were laid half an inch apart, with a view to a more ready mode of cleaning the place by sweeping the dust, &c., between the boards. Very serious inconveniences arose from this method of laying the floors, among which, the almost certain loss of any small article or trinket that was dropped, was not the least. The proposed system of introducing a number of moveable receptacles of the dust, is calculated to obviate the inconveniences experienced in London, whilst it will retain all the advantages of speedy and thorough sweeping."

Upon the use of glass for the roof, the following observations were made, which are applicable to such structures in climates warmer than ours:

"The different roofs are intended to be covered with lead and tin. The character of a 'Crystal Palace' will be amply preserved by the free use of glass on all sides of the octagon, cross, and dome; but it is believed that a glass-roof, like that used in London, would be pernicious to the interior of the building, as the brightness of our sky would be much too glaring for endurance, if received through the medium which was so appropriate in England. Moreover, a glass-roof would be found the source of serious annoyances, chiefly in winter time for instance, in case of heavy snow."

Some amusing correspondence will be found in the Appendix, on the mode of paying the architects' remuneration,—Brother Jonathan having still a very strong objection to pay hard cash, or even paper, when anything can be done in the way of swapping, so that the poor architects had to take great part of their small remuneration in shares.

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*Electro-Magnetic Telegraph, with an Historical Account of its Rise, Progress, and Present Condition, &c.* By LAURENCE TURNBULL, M.D. Philadelphia. 1853.

[SECOND NOTICE.]

Before resuming our historical notice of the various steps by which the art of electro-magnetic telegraphing attained its present perfection, we will notice the interesting experiments conducted by Mr. A. Bain, in which the earth was made the source of permanent voltaic electricity.

In 1841, it was found, during some experiments with an electro-magnetic sounding-apparatus, that in consequence of the imperfect insulation of the conducting-wire from the water, the attractive power of the magnet continued, notwithstanding that the circuit was broken. This phenomenon was further investigated at the Polytechnic Institution with great lengths of wire, when the same results were obtained, which afterwards induced Mr. Bain to conclude that a permanent battery might be made by burying in moist earth or water a surface of positive metal and one of negative metal, and establishing a metallic connection between the two by means of a wire. This proposition was accordingly acted upon in Hyde-park, where a copper and a zinc plate were deposited in the earth, and connected by a wire suspended on the railing. On placing a galvanometer to the wire, an electric current was perceived, with which an electrotype process was conducted, and several successful electro-magnetic experiments performed. Mr. Bain patented the application of this mode of producing electric currents to his printing telegraph in 1841; but as this natural battery requires for long distance a great increase in the number of plates, and is capable of producing only very feeble currents, it has been abandoned as a generative source of electricity.

In the year 1840, Mr. W. Sturgeon published in the 'Annals of Electricity,' descriptions of his ingenious and simple systems of indicating telegraphic messages, in which numerals or a combination of numerals are made to represent certain preconcerted signals. In one system the apparatus consists of six soft iron bars, bent into the form of horse-shoe magnets, and covered with copper wire in the usual way. Immediately above each magnet is suspended a lever, having at its short end a cross-piece or keeper, which, when the magnet is excited, is attracted towards the magnet, and raises the long arm of the lever, to the end of which is affixed a circular piece of card bearing a numeral, which becomes apparent to the observer through a circular opening in the dial-plate of the apparatus. These six magnets and levers are so arranged that their respective numbered cards shall appear through openings ranging in a horizontal line in the face or dial-plate, so that the numerals may appear in proper consecutive order. The transmitting instrument consisted of an arrangement of keys, numbered in a corresponding manner to the receiving-magnets, the depression of any or all of which consequently indicated the like numerals at the opposite station. In a modification of his telegraph, Sturgeon employed magnetic needles in place of the levers and magnets. These needles were arranged in a row, and when deflected by the electric current they pointed to a series of numerals marked on the dial-plate, or they might be made to point to letters alphabetically arranged in three horizontal rows. It does not appear that Sturgeon's instruments, although simple and capable of being rapidly worked, have been practically employed.

In 1846, a printing telegraph was tried on the Paris and Rouen line, the invention of Dr. Dujardin, of Lille, which consisted of a transmitting and a receiving instrument, actuated by magneto-electric agency. The receiving instrument was composed of a permanent magnet, each of the two poles of which were enclosed by a coil of wire in connection with one another. Opposite to the two poles was supported a revolving armature, capable of being moved by driving and multiplying wheels, one-sixteenth part of a revolution of the driving-wheel causing the armature to make a quarter-revolution, when a current of electricity was generated and transmitted to the receiving instrument, and returned by the earth. The recording apparatus consisted of a hollow drum of metal, to which a slow rotary motion was imparted by a crank actuated by clockwork; and at the same time the drum received a lateral motion from a screw turned on its axle, in a manner similar to that of Mr. Bain. On this drum was stretched the paper to be acted upon. An electro-magnet was fixed under the drum, which was in connection with the generating magnet at the transmitting-station. In front of this electro-magnet was a pen, consisting of a bent silver wire, dipping in a trough of ink, and soldered to a piece of iron wire, mounted and balanced on a pivot, from which depended a piece of watch-spring, having at its lower end a permanent magnet, which hung immediately in front of the poles of the electro-magnet beneath the drum. On the transmission of a current of electricity, the electro-magnet became magnetised, and in consequence of its north and south poles being opposite to the north and south poles of the permanent magnet attached to the pen, the latter was strongly repelled, which caused the pen to rise from the trough of ink, and to mark the paper surrounding the drum. With Dujardin's telegraph about ninety words were printed per minute, at a distance of 400 miles from the transmitting instrument.

We next come to the printing telegraph of Mr. R. E. House, which is worked in the United States to a considerable extent. Mr. House was occupied six years in developing his invention, which was patented in America in 1848, to date from April 1846, the interim between these dates being occupied by the Examiners in considering whether House's system clashed with that of Morse. The chief apparatus connected with this telegraph consists of the printing machine, a compound axial magnet, the motive power and the letter wheel by which the messages can be read in case of failure of the printing machine. At every station a composing and a printing instrument are required, which last is distinct from the circuit, whilst the former is included in it. The composing instrument consists of an insulated iron frame placed immediately below a set of keys, marked with the letters of the alphabet, a dot and dash. Within this frame is a revolving-shaft, inclosed the greater portion of its length within an iron cylinder, the shaft being made to revolve by a band and pulley. The cylinder is detached from the shaft, but made to revolve with it by a brass flange fastened to the revolving-shaft, and acting against the inner surface of the circuit-wheel. This friction contrivance admits of the revolution of the shaft, whilst the movement of the cylinder can be arrested. The circuit wheel or break is fixed at one end of the cylinder, and is divided into twenty-eight equal spaces, each alternate space being cut away, thus leaving fourteen teeth and fourteen spaces. The revolving-shaft and cylinder form part of the electric circuit, one point of connection being where the shaft rests on the frame, the other through a spring, which presses on the circumference of the circuit-wheel; so that as this wheel, the shaft, and the cylinder revolve, the current is alternately closed and broken. The depression of any one of the keys above the iron frame causes the cylinder to stop, by the key coming in contact with one of a corresponding series of stops, arranged around the cylinder, which has the effect of keeping the circuit either broken or closed, according as either a tooth or a space of the circuit-wheel may happen to be presented to the spring. From one to twenty-eight openings and closings of the circuit take place between the depression of the two different keys or the re-depression of the same one. The rapid electrical pulsations thus produced are transmitted by the circuit of conductors to the magnet and printing machine at another station through a conducting-wire. The helix of the magnet is an intensity coil contained within a steel cylinder, having its axis vertical. Within the helix are arranged six or eight soft iron tubes, soldered to the interior of a short brass tube. A brass rod is suspended from an elastic wire or spring above the magnet, and passes down within the soft iron tubes. Upon this rod is strung six or eight small iron tubes with bell-like flanges. On the transmission of an electric current through the helix, the tubes within the brass tube and those attached to the rod become magnetic; and such is the arrangement of their polarities, that they act by attraction and repulsion, overcome the elasticity of the spring, and bring the moveable magnets down to the fixed ones, which breaks the current, when again the spring separates them. Above these magnets is a valve, having on its outer circumference several grooves, which open into an air-chamber in which a piston moves; the action of the magnets already described allows the air alternately to pass through the grooves to the back and front of the piston within the air-chamber, thus imparting a reciprocating movement to a lever of an escapement connected with the piston. The pallets of this escapement act on the teeth of an escapement-wheel of the printing machine, and cause it to revolve to the extent to which the circuit-wheel of the composing machine has been made to move. A steel type-wheel, marked with the alphabet, a dot and dash, is fixed above and revolves on the same shaft as the escapement-wheel. A mechanical contrivance causes the paper to be presented to the type-wheel, which is inked by a band passing between it and a second toothed wheel. When the type-wheel stops a detent arm revolves, carrying with it an eccentric, which, by means of a connecting-rod, draws the toothed wheel having the paper and colouring-band before it against the type, and an impression is made on the paper. A letter is printed if the circuit remains closed or broken longer than one-tenth of a second; three hundred letters, in the form of Roman capitals, can be printed in one minute. The operator, in transmitting a communication, sets the machine in motion, which gives a signal to the receiving-station, and then, with the message before him, commences to play like a pianist on his key-board, touching in rapid succession those keys marked with the consecutive letters of the information to be transmitted. The receiver at the opposite station having set his machine in motion, sets his type at the dash, sends back a signal that he is ready, and the communication is proceeded with. He can leave his machine, as it will print in his absence; and when the message is completed, he tears off the strip of paper on which it is printed, and forwards it to its destination. As Dr. Turnbull says, "the function of the electric current in this machine, together with the compressed air, is to preserve equal time in the printing and composing machines, that the letters in one may correspond with the other. The electrical pulsations determine the number of spaces or letters which the type-wheel is permitted to advance; they must be at least twenty-five per second to prevent the printing machine from acting. The intervals of time the electric currents are allowed to flow unbroken are equal, and the number of magnetic pulsations necessary to indicate a different succession of letters are exceedingly unequal; from A to B will require one-twenty-eighth of a revolution of the type-wheel and one magnetic pulsation; from A to A will require one entire revolution of the type-wheel and twenty-eight magnetic pulsations." The first line on which this instrument was employed was completed in March 1849, from Philadelphia to New York, since which period it has, we believe, come into almost universal operation in the United States.

From 1847 to the present time the number of improvements in and modifications of existing forms of electro-magnetic telegraphs has been very great, many of them exhibiting much ingenuity and skill, although it is not necessary to describe them to complete our history of the science.

A novel though imperfect method of recording telegraphic despatches, patented in America by C. F. Johnson in 1848, consisted in forming signs by the dropping of balls upon an endless belt moving with a uniform velocity, which imparted impressions upon moving paper.

L. G. Curtis, in 1849, proposed an indicating telegraph, consisting of a disc or dial-plate, marked with numerals or letters, and made to revolve to the desired extent by the alternate breaking and closing of the electric current.

Some of the most important recent improvements in electro-magnetic apparatus are those of Messrs. Henley and Foster, which consist in—first, an arrangement by which a visible index hand is directly acted upon by a single magnet, suspended within the sphere of influence of an electro or other magnet, having each of its extremities converted into two or more poles; secondly, the keeping of the magnetic pointer in one position for any length of time, or imparting to it any number of distinct deflections by means of the induced current, and as rapidly bringing it to its stationary position by the residual magnetism or the reversed inductive current, thus rendering the movements of the needle more rapid and distinct than heretofore; thirdly, an arrangement whereby two distinct currents of equal intensity may be derived from the same magnet, and single or double currents may be sent through any number of instruments at different stations; fourthly, an improved apportionment of the signs or symbols, whereby the number of movements requisite for their production is considerably reduced; fifthly, a current reverser of peculiar construction, which dispenses with the use of magneto apparatuses for deriving currents of electricity, substituting in lieu thereof voltaic batteries, such reverser completing the circuit twice during its motion. This patent, which was obtained in 1849, also included a new compound for covering conducting-wires, and a method of regulating timekeepers from one primary or standard clock, which need not be alluded to here.

Henley's telegraph was experimented with by the French government on the line of railway from Paris to Valenciennes, a distance of 180 miles. The wires were connected so as to treble the length of wire, making 540 miles to and from Paris and back; the magnetic messages being communicated through the first wire, back by the second, through the third, and back again by the earth. In this experiment no batteries were employed, the apparatus being worked first with full power and afterwards with one-twentieth of the power, when the signals were made with remarkable rapidity and distinctness, although the ordinary telegraph of the line, with battery power, was not able to produce the slightest effect.

In 1850, W. S. Thomas proposed the making of signals by the agency of heat, generated or controlled by a current of electricity passed along wires, the signals being flashes of light emitted by points or conductors, marks being produced upon paper by the heated point.

In the same year, J. L. Pulvermacher, of Vienna, patented a method of varying the intensity of the electric current, either by increasing or diminishing the number of elements employed, or by interposing more or less powerful resistance to the current; also the substitution of a letter-cylinder for the letter-wheel ordinarily employed. The application of a double escapement, each capable of assuming four directions, and each producing effects different from those of the others, together with other modifications in the detail of electro-magnetic apparatus.

Ernst W. Siemens effected some important improvements in the construction of magnets, and the methods for obtaining motion for telegraphic purposes by means of one or two electro-magnets revolving on their axes within fixed coils; and also by employing metallic spiral coils or bands, traversed by electric currents, and attracting or repelling each other; or again, by the proximity of such spirals to permanent magnets, which at the same time serve to produce electric currents by induction for working telegraphic apparatus. He further proposed the combination of elecric printing instruments in the same circuit with indicating apparatus, when the magnets, which work the step-by-step motion of either or both instruments break and restore the circuit by the oscillation of the armatures or magnets themselves, together with other valuable suggestions relating to telegraphic mechanism. Siemen's telegraph was submitted to the Academy of Science, Paris, who reported it to possess "incontestable superiority over all other like apparatus," and to surpass in speed all other alphabetic telegraphs.

In June 1850, G. H. Horn proposed an electric telegraph, similar in principle to that of W. S. Thomas, in which the igniting effect of electricity was made, through the medium of a fine platinum point, to burn a hole or holes in a moving fillet of paper. The instrument consisted chiefly in clockwork and spool, required for giving the proper movement to the paper. This register required a quantity current to effect the ignition of the point, and therefore a receiving instrument and local battery were necessary to the efficient working of the receiving apparatus.

Batchelder and Farmer also proposed a similar pyrographic telegraph register, employing a spirit-lamp to heat the marking wire, and recording the signal upon various kinds of paper, such as pink tissue made from linen stock, in the form of a fillet or a large sheet, the slightest contact of the heated wire with which was sufficient to produce a straw-coloured mark.

In the same year was patented, by Thomas Allan, of Edinburgh, an arrangement by which the letters, words, and sentences composing messages were divided into sections or divisions, so that they might be signalled, by means of their number and position, in any given section, thus materially decreasing the labour and expense of telegraphic conveyance. Also, a combination of magnets, arranged in pairs, of convenient shape for permitting the ends or poles of electro-magnets to be introduced between them, thus producing a large accumulation of magnetic power within a small compass. These improvements seem likely to lead to great simplification and economy in working existing needle telegraphs.

We have now traced the progress of the science of electric telegraphing from the earliest discoveries of Œrsted, and the experiments of Winckler, Lemonnier, and others, down to the present systems of Wheatstone, Morse, Henry, Brett, and many others, whose ingenious instruments, actuated by the dynamic force of the electro-magnet, transmit and record, at almost fabulous distances, the various languages of civilised nations. It has not been our province to pronounce as to whom the merit of originating the idea of rendering the electric fluid subservient to the purposes of man, belongs; nor even to decide between the rival claims of Morse, Wheatstone, House, or Davis, to be considered the first to record or print messages by electro-magnetic agency; or those of Brett, Bakewell, or Baggs, as regards the employment of the electric current to decompose or form new chemical combinations. These we have left an open question, and have merely detailed, with the assistance of Dr. Turnbull, the gradual development of this extraordinary science. At the same time, we must observe, that our limited space has prevented us from doing justice or even alluding to the improvements of many who have done much to promote electro-magnetic telegraphing.

It now remains to be shown to what extent these numerous systems have been practically adopted, both in the New and Old

Worlds, commencing with America, which, from the vastness of its territories and the remarkable cheapness with which telegraphs are constructed in that country, possesses the greatest number of miles of telegraph. The moderation of the charges made for the transmission of messages in America has also imparted a stimulus to their extension and general employment, which is wanting in this country, on account of our exorbitant tariff of charges. The bold spirit of enterprise which characterises our transatlantic brethren as much in scientific as in commercial matters, has caused the telegraphic wire to link the remotest verge of civilisation on the western frontier, beyond the Rocky mountains, with the north-eastern extremity of the United States; and the time is not far distant when the Mississippi will be connected with San Francisco, a distance in one unbroken line of 2400 miles. The route selected by the committee for this line, according to the survey of Capt. W. W. Chapman, will commence at the City of Natchez, in the State of Mississippi, pass through a well-settled portion of northern Texas to the town of El Paso, on the Rio Grande, thence to the junction of the Gila and Colorado rivers, crossing at the head of the Gulf of California to San Diego on the Pacific, thence along the coast to Monterey and San Francisco. By this route, the whole line will be south of latitude 33°, and consequently be almost entirely free from the great difficulties to be encountered, owing to the snow and ice on the northern route by the way of the south pass, crossing the Sierra Nevada mountains in latitude 39°. This Pacific Telegraph Company is now fully organised, with Mr. H. O'Reilly, the projector of the scheme, as president, and Mr. T. P. Shaffner as secretary, with a capital of 5,000,000 dollars.

Many of the existing telegraph lines in America are of a length which, from the limited extent of our island, are unknown in this country; as, for instance, the two southern lines, one from Cleveland to New Orleans by Cincinnati, 1200 miles long, the other from Washington to New Orleans, by Fredricksburg, Charlestown, Savannah, and Mobile, which is 1700 miles in length; this line has been extended west to Independence, Missouri. The entire length of telegraphic line from New York to New Orleans, *vià* Charlestown, is 1966 miles, which distance is not worked in one continuous circuit, nor can it be so, on account of the imperfections of known means of insulation. Direct communication can only be effected by the employment of an instrument termed a connector, first invented and applied by E. Cornell, of New York, in the year 1846. The effect of this instrument is to cause one of the circuits into which the line is divided to work the next, and so on through the entire series of short circuits. This instrument has also been used on the New York and Erie, Erie and Michagan, New York to Milwaukie, and New Orleans lines, with perfect success. The total number of miles of telegraph wires in the United States amounted, up to the returns of last year, to 24,375 miles, of which 19,963 miles are worked with Morse instruments; 2400 miles with those of House; and 2012 miles with Bain's apparatus.

After America, England possesses the greatest length of telegraph lines, which are estimated by Dr. Turnbull at 2225 miles, but as this number represents the length of railway lines, and not the total length of telegraph wire, as in the case of the American lines, where Dr. Turnbull (whether for the sake of more favourable contrast of those of his own country with the English, or whether such calculation happens to be the one usually adopted in America, is of little consequence) has multiplied the miles of country over which the telegraph extends by the number of wires employed in working them. But when such course of proceeding is applied to the telegraphic lines of England, the necessary length of wire amounts to 9939 miles, which, considering the relative proportions of the two countries, would doubtless strike the balance rather in our favour than otherwise.

Since 1850, when the estimate above given was made, the electric telegraph has made considerable progress, but to what extent no returns have been given. The instruments usually employed are those of Cooke and Wheatstone, Jacob Brett, and Brett and Little. Bain's electro-chemical telegraph is worked from London to Manchester, and from thence to Liverpool, and also from Edinburgh to Glasgow.

In Prussia, the electric telegraph is worked in a very simple and economical manner, the wires being generally buried, and made to follow in the track of railways; but one wire is employed, and the instruments by which the signals are transmitted and recorded are those of Siemens and Halske, Kramer and Morse, together with Daniell's battery. The total length of wires radiating from Berlin is estimated at 1493 miles.

The Austrian telegraphs extend over a length of 1063 miles principally employing the apparatus of Morse, modified by Robinson; of Bain, modified by Ekling; and those of Storer and Stoehrise.

Owing chiefly to the government surveillance over the telegraphs in France, and the high tariff charged, France is considerably behind most European nations in telegraphic enterprise. The latest returns give no more than 750 miles of electric accommodation, on which the instruments of Brequet and Foy are generally employed, together with those of Wheatstone, Dujardin, and Gardiner. Brett's apparatus is used on the line connecting England and France between Dover and Calais, and Bain's chemical telegraph has been lately introduced.

Saxony and Bavaria have government lines, which connect with the Prussian and Austrian lines, and establish a communication with Berlin, Dresden, Munich, and Vienna. In Saxony, the telegraph wires extend over 265 miles, and in Bavaria over about 455 miles, and are principally worked by Stoehriss's needle instrument and his bell apparatus. The Tuscan lines of wire amount to about 363 miles in length, the telegraphic apparatus being furnished by Brequet and Pierucci.

In Holland, Italy, and Spain, the railroads are generally provided with telegraphs, which, with those of Prussia, Austria, France, Russia, and other countries, are being rapidly brought into connection with each other, and are gradually converging towards our own island, with which, before long, they will be in direct communication.

In the East Indies, a line of telegraph has been constructed between Calcutta and Kedgeree, a distance of seventy-two miles. On this line thick rods are employed in place of wires, which are laid part of the way underground, the remainder being supported upon bamboo poles. No insulating apparatus is used, as the thickness of the conducting materials insures the passage of the electric current, and at the same time prevents danger of breakage by wild beasts, or the swarms of kites and crows that perch upon it in the swamps. A proposition to connect all important places in the British possession is now being rapidly put into execution, and will require about 8800 miles of telegraph wire.

When we reflect that the above and numerous other electric lines have been constructed within the last eight or ten years, and that at the present moment telegraphic projects are afloat, and many of them in construction, in which far greater distances are embraced, and more gigantic difficulties are encountered, than in any telegraph lines already accomplished, we may safely look forward to the not distant period when the whole globe will be covered with a network of electric cords, annihilating space, and linking in a bond of intelligence the most remote nations.

Appended to the work of Dr. Turnbull are chapters on electric insulation and wire protectors from lightning; accompanied by several important telegraph decisions of American courts respecting the claims of Morse and Bain; the Electric Telegraph Company *v.* Brett and Little; and Morse and Vail *v.* F. O. Smith.

In these days of more practical acquaintance with the phenomena and laws of electrical science, we may reasonably expect greater results from such knowledge and, though it would scarcely appear possible, still more perfect electro-magnetic instruments; or probably, the new system termed magneto-electricity, in which the inverse or secondary current induced by magnetic action is made use of, may become more practically developed. These considerations induce us to hope that similar works to that of Dr. Turnbull may appear from time to time, recording the progress of this most serviceable and interesting science.

## STATE AND CONDITION OF THE BRIDGES OVER THE THAMES.

REPORT *of the Select Committee of the House of Commons appointed to inquire into the State and Condition of the Bridges over the Thames, in the Metropolis; to report whether they are adequate to the present vastly increasing traffic; whether it be desirable to construct one or more Bridges over the River; and, if so, at what point or points.*

YOUR committee have examined witnesses with a view to discharging the duty entrusted to them, and have, in the first place, directed their attention to the state and condition of the several metropolitan bridges. With respect to these, they have to report that, with two exceptions, namely, Blackfriars and Westminster, the whole of the metropolitan bridges are, in a satisfactory and durable condition. Southwark, Waterloo, and Vauxhall Bridges, and Charing-cross Foot Bridge are toll-bridges in the hands of private companies. As to Blackfriars Bridge, the evidence brought before your committee leaves no doubt as to its being in an unsatisfactory state; and the Court of Common Council has approved of a proposal for removing the present structure, and replacing it by a new bridge. Your committee do not consider it within their province to report on the condition of Westminster Bridge, as a contract for pulling it down and rebuilding it has actually been entered into.

With regard to the adequacy of the present bridges in the metropolis to accommodate the existing traffic, your committee have examined numerous witnesses, whose opinion they consider valuable as connected with the bridges; and they report that the present accommodation is insufficient; that there is every probability of this deficiency being still further felt, and that it is necessary to adopt measures to mitigate the evil. To meet this end, several schemes have been submitted to your committee: 1st. It is proposed to open free of toll those bridges which are at present private property. 2nd. To increase the width, and consequently the convenience of some of the existing bridges. 3rd. To enlarge and improve the approaches to them. 4th. To make the Thames Tunnel available for traffic. 5th. To construct a tubular iron superway, so as to connect the most important points in the metropolis; and, lastly, to build additional bridges.

After a careful consideration of the evidence which has been brought before them, your committee consider that the expediency of removing the present tolls, on the different bridges between Staines and London Bridge, is established. They find that, by the present system, the traffic is diverted from the direct route; and, in consequence, the open thoroughfares are choked, and rendered at times almost impassable, by the collection of merchandise and passenger traffic, which would disperse and spread itself if there were more channels of escape provided. This inconvenience is especially felt at London Bridge, where not only delay, but even danger is incurred by the concentration of traffic on one spot, owing not only to the ordinary London traffic, but to the additional traffic produced by the neighbouring railway termini. Similar inconvenience is felt at Westminster; and your committee are of opinion, that in both instances it would be materially diminished if the intermediate toll bridges were thrown open to the public. The evidence with respect to the bridges from Vauxhall to Staines establishes the fact that, by the present tolls, not only is the public inconvenienced, local trade impeded, and the accommodation diminished, but that the burden of the tax falls most heavily on those who are least able to bear it.

Your committee are of opinion that, although it may become necessary, owing to the ever-increasing traffic of the metropolis, to build additional bridges, it will be better, in the first instance, to ascertain the effect of throwing the present toll bridges open to the public, provided they can be obtained on reasonable terms.

Upon the question as to whether additional bridges are required, your committee have examined Mr. Brennoch, Mr. Tite, Mr. Page, Mr. M'Lean, and other competent witnesses. These witnesses agree in the necessity for providing further means of communication across the river.

The sites proposed by them are—

1st. Tower Hill, below London Bridge.
2nd. St. Paul's.
3rd. Charing Cross.
4th. Horseferry Road.

Without entering into the comparative merits of these several propositions, your committee are of opinion, that the bridges opposite Charing Cross and St. Paul's will become speedily necessary, especially should the negociation with the proprietors of the toll-paying bridges prove abortive.

With regard to the best mode of providing for the purchase, and the future maintenance, and increase of the bridge accommodation, your committee are decidedly of opinion that a rate to be levied over the whole district to be benefited by the proposed alterations is at once the most just and the most simple plan to be adopted.

## SEPULCHRAL MONUMENTS OF THE CEMETERY OF BONN.

Many of the sepulchres of the famous Rhine University possess not only a historical, but also an artificial importance. Here the very praiseworthy custom of placing faithful counterparts on the graves of the good and illustrious has been much resorted to, as, for the acute observer, the physiognomy of man is perhaps his best biography. The busts of Niebuhr and his spouse placed on his mausoleum are exceedingly well executed; the monument being erected by King Frederic William IV. to his former tutor and teacher. Although the memorial tablet of A. W. Schlegel is much more simple, the bronze bust is one of great resemblance, exhibiting a noble cut of head, with a brow furrowed by many a deep thought. A head of equal importance is that of M. de Rehfues, late Curator of the University; the fine lineaments of which bespeak the spirited author and statesman. Attached to a lateral wall is a monument of the Swedish regicide, Lilienhorn, who concluded in Bonn a life of deep suffering. Equally melancholy stands a high cross of granite amongst weeping willows—the gloomy memorial of a youth of eighteen, distinguished by stately form, poetry, and love; it is that of the suicide, Karl von Hohenhausen, one of a family of poets. More cheerful, because of eternal renown, is the mortuary hillock which conceals the ashes of Melchior Boisserée, the elder of a pair of great men. His fine dwelling, replete with master-paintings of every school, belongs new to the surviving brother, Sulpiz Boisserée, but being of a more eccentric character, he does not receive those numerous foreign guests who formerly thronged around these works of genius. Melchior Boisserée reposes now, after much labour and renown in other lands, on the paternal Rhine, while the Dome-work in the "Holy Cologne" progresses—an eternal memorial of the sure success of any sincere and well-grounded endeavour.

## THE RESTORATION OF THE SOUTH GABLE OF THE CATHEDRAL OF VIENNA.

The Cathedral of St. Stephen, at Vienna, forms, with those of Cologne, Strasburg, and Freiburg, a complex of the finest examples of Pointed architecture. It was as early as 1144, that Henry II. of Babenberg (called Jasomirgott, Duke of Austria) erected, on the ruins of an old chapel, a building which, by succeeding additions and enlargements, grew up to the present huge structure. According to some lately-discovered documents, it was Octavius Falkner, a master mason of Cracow, who built this primeval church, of which, however, nothing but the main walls of the great nave and the west front with the giant's door remain. The whole of the lower part of the western façade betrays the exclusively Romanic style, while the pyramids of the two exterior steeples exhibit already traces of the style of the Pointed architecture. Duke Albert II. first commenced to enlarge the Cathedral. The west side was considerably raised, and it was only under his successors that it was planned according to its present form. In 1359, the foundations of the lofty steeples were laid, which great work was effected by a comparatively humble individual, Master Wezla, of Klosterneuburg. He placed the new steeples above the projections of the nave, as the principal front, which had to remain intact, had already two similar structures. The numerous statues and ornaments which were placed in the interior and exterior of the vast building, were made by U. Helbling, H. Kumph, and C. Horn. The main steeple was not completed until 1433, so that its construction occupied a period of seventy-four years. Here, it seems, the vigour of the middle ages had been expended, as the second steeple was never completed, and only somewhat built over and covered with a copper roofing in 1579. The whole length of the completed steeple is 435 ft. 6 in.; the whole length of the Cathedral 342 feet; the width of the middle nave between the pillars (of 8 feet thickness), is 33½ feet; that of the lateral nave, 28 feet; the height of the middle vaults, 86 feet.

As the completed steeple lays on the southern façade, it is this which presents the finest view of the building, and the richness of ornament is most apparent, the which had just taken hold of Gothic architecture when St. Stephen's, of Vienna, was built. Very richly ornamented are the flying buttresses with the double windows between them; arched vaults, with all the finery of mediæval art, extend before the doors; and the steeple, reaching far into the skies, presents numberless finials, like stone carving. It is to be regretted, that of the four steep gables, which project over the height of the walls, only that on the west side was completed—probably by Puchsbaum, in 1430. This has a perforated pediment, which, beginning above a straight gallery, presents below three collateral gables, above which rises the chief gable, surmounted by a crown. The three other gables have only the appearance of simple walls, and contrast very much with that so highly ornamented. The municipality of Vienna proposes, therefore, to restore or rather rebuild these three gables, which would fully complete the ensemble of this fine old Cathedral. The estimates of each of the gables have been laid down at 18,000 florins.

## CHAMPION'S TAPERING DOUBLE LEVER BRIDGE.*

The accompanying engraving is a perspective view of an improvement in bridges, by Samuel and Thomas Champion, of Washington, U.S.

This bridge is a tapering double lever, skeletonised and balanced upon a pier, reaching, in moderate spans from the pier to either shore, and may be swung round as a draw, opening the whole stream by rollers underneath on the top of the pier.

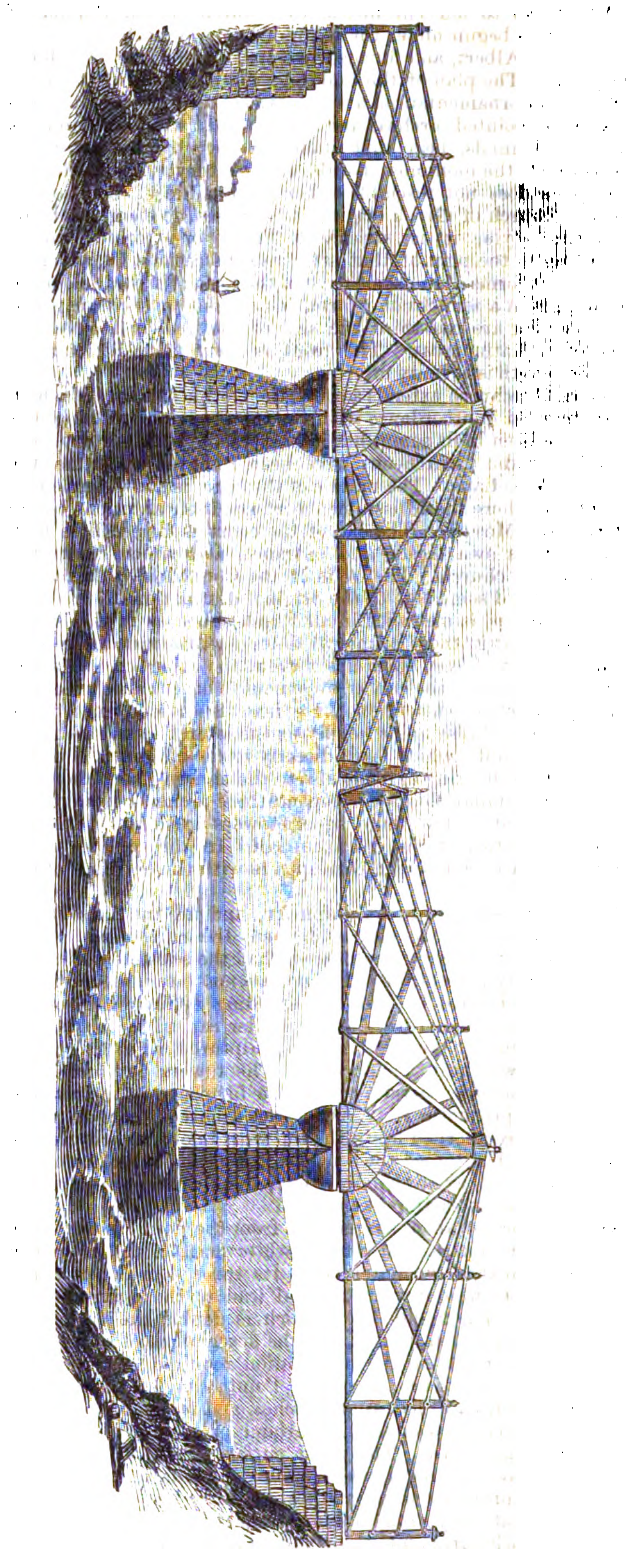
In wide streams, where several spans are required, each section of the length of the bridge will reach from each pier to midway between the piers. Where no draw is required each section may continue in one unbroken connection from the centre of the pier to the foot of the side piers each way beyond. By this plan of bridge, the principal weight and crushing force is thrown to the under side of the bridge, the lighter being above the heavier, giving an opportunity for cross and other bracings, where they are most required.

The commencement of this bridge is in a hub on the pier, in which are recesses for the reception of a series of upward diverging, tapering wrought-iron tubes, radiating like the rays of the half-risen sun, for the purpose of throwing all compression to the foot of the centre column, as all suspension is centered upon the cap on the top of the centre or vertical column, over which, in recesses at the proper angles, all the suspenders pass, and from which they diverge downwards, as the tubes do upwards, each in straight lines—nothing curvilinear in the compression or suspension. These being equal to each other, the expansion is equal; what one gives upward the other does downward, so that the whole remains comparatively stationary.

At proper intervals, throughout the length of the bridge, clamp posts are attached reaching from the upper terminus of the tubes to the lower termini of the suspenders, embracing each tube and suspender as they pass the posts, clamping by bolts through said posts, all tubes, suspenders, and posts, and holding all in a state of rigidity and tension, which is regulated by gib-and-key connections in the suspenders.

By this system, in which the principles of the lever are analysed, and skeletonised—as by placing the crush resistants on the under side, and the stretch or tension resistants on the upper side, with the correct principle of taper properly maintained and proportioned, any desired length and strength of span may be obtained, there being (as the inventors conceive), no limit in the principle, except in cost and expediency, it being cheaper to erect additional piers, where it is practicable to do so, than to increase the size of all parts from the centre between the piers, to the piers at their greatly increased distance apart. It will be perceived that this bridge is never loaded in the centre with burdensome weight, however lengthy the span may be, but remains at rest and equipoise when no train is passing over it. Iron bridges, which are as heavy in the middle as at the piers, are always loaded, and sometimes very heavily, too, by their own weight alone, and are often breaking down, and would do so in a few years if no weight were placed upon them.

Believing this principle to be true and demonstrable, as capable of indefinite extension—that any desired length of span may be obtained for the support of any desired weight, the Messrs. Champion present the same to the consideration and criticism of a discerning and impartial public. They also call particular attention to the capacity of the tapering suspenders for great length of span, far beyond the one size wire suspension, to say nothing of the advantages of the straight suspenders in their permanency and rigidity over the oscillating inverted curve suspender. In this bridge the permanent and suspension meet, and the anchoring is part of the bridge; the shore end (when not intended for a balance swinging draw) is considerably longer from the pier to the abutment than to the centre between the



piers beyond, forming by such additional length, an anchor and counterbalance to the weight of a train between the piers beyond: thereby placing everything in sight above the danger of rust below.

* From the 'Scientific American.'

## THE CATHEDRAL OF NIKOSIA, IN THE ISLAND OF CYPRUS.

By A Recent Traveller in the East.*

According to old chronicles, the church of Sta. Sophia, of Nikosia, was begun under the reign of Henry I. of Lusignan, by Archbishop Albert, and finished in 1228, under Henry II., King of Cyprus. The plan of the building, the ensemble of its architecture, and ornamentation, are in perfect keeping with its style of slender pointed arches; and the portal, windows, and its foliage and finials, bear that stamp of stern symmetry which appertains to the monuments of the 13th century. The Cathedral of Cyprus does not resemble either the Basilica of Constantine nor any church of Greek origin; it possesses no element of the Byzantine style; it is strictly a Frank or Gothic church. According to the plan of that style and the century in which it was built, it forms a handsome nave in the form of a parallelogram, which ends in a semicircular form, and obtains by the transversal naves, which are one-third the size of the principal nave, the form of a Latin cross. The front is forty mètres broad, its exterior length is seventy mètres.

Before the church extends a court, the Gothic entrance of which is ornamented in accordance with that of the main building, but must have been built somewhat later than the 13th century, and several heraldic escutcheons have been removed by either the Turks or Venetians. The middle of the court is now occupied by a fountain, where the Mussulmen perform their ablutions before entering the Mosque. The end of the court is formed by a hall, possessing its own façade and entrance, and which fronts the portal of the church. The Acts of the Council of Nikosia will probably afford some clue to the original destination of this hall, which, however, is met with in all Frank churches of the island. It may be, that in those primæval times it was destined to receive the penitents and keep them apart from the other congregation. Still, the absence of such an arrangement in other churches of the same epoch claims attention. Its floor is divided into three compartments of dissimilar height, as the lateral parts rise above that of the middle, which leads directly to the church. This distinction of the flooring extends also to the church itself, and with the three dissimilar floors correspond three arches, whose pillars are also separate. Two large, square towers are at the north and south extremities of the entrance hall. In the middle of the latter opens a portal, which corresponds with the entrance of the church.

The façade is one of great simplicity, and all the lines of the towers and base are so clearly defined, the rich foliage which adorns them so sharply sculptured, that the scantiness of ornament is hardly perceptible. The portals and lateral doors of the entrance are formed by columns standing behind each other, which are surmounted by a very slender capital, which is only just broad enough to receive the sculptured roses and fern-leaves with which it is adorned. The towers have at their angles little square turrets, which are furnished in their whole length by a prismatic rib. Above the archivolt runs a gable, whose sides are adorned up to the top with knobs, which present a fine relief. The top of the southern tower and the point of the middle gable, &c., exist no more; that part of the building having been ruined by an earthquake in 1491.

At a distance of about six mètres from the portal is the inner façade of the church, entirely of white marble, and of richer ornamentation than the outer one. Its three doors open opposite to those of the outer portal, and lead to the main and the lateral naves. The middle door, which is double the size of the others, has been much injured, but the description of one of the lateral doors supplies all the information required. The upper arcades of the doors are all of the Pointed style; the middle, however, is vaulted in flat, round arches, and in one of the upper apertures a square is visible. A garland of roses in alto-relievo surrounds this square. The inner surface of the vaults represents some leaves of trefoil, which seem to have formed a canopy, under which probably some statues of saints were once placed. Above this first story rests the tympanum and the archivolt. The archivolt, which surmounts the whole, is divided into four circles. Each of these secondary archivolts reposes on a broad leaf, which much resembles a species of arum, a plant to be met with in Cyprus. The inner portion of the arcades is ornamented with garlands in basso-relievo. But the architectural works of the 13th century were of a stern character, and did not permit of that fanciful variation which led in subsequent centuries to a confusion of taste and the rules of art. There, yet, everything seems to have been deeply calculated, everything had its well-ordained plan, and the aspect of those structures was most cheerful and pleasing, notwithstanding the sternness of character which pervaded them.

* From the 'Allgemeine Bauzeitung.'

In its ensemble the Cathedral of Sta. Sophia of Nikosia forms a long nave, whose parts are thus arranged. The entrance hall, has on its anterior end a square, and on its posterior part a round tower; and the central portion, which is divided by the height of the walls of the middle naves into two stories. The apsis, which has buttresses like the nave, is pierced by long windows. Over the lateral naves runs a terrace of 10 feet breadth all around the church; further above, a second platform reaches over the whole middle nave, and concludes the whole structure.

The round tower is furnished with a winding staircase throughout its height, and has five stories, which are marked outward by thick mouldings. It formed part of the old building, but then it reached only to the height of the square towers and the terrace. On the top of the round tower, the Turks have raised two minarets of forty to fifty mètres in height, which overtop all others, and command a vast view of the whole place.

The transverse naves end at this inferior angle in a hexagonal tower, and on their upper corner in a square one, which is less ornamented than that of the portal. The hexagonal tower contains also a winding staircase, and is surmounted by a lantern, at the base of which begins one of those graduated buttresses, which ascend to the upper platform. The middle of the lateral naves was formerly occupied by a large rose window, of which merely the circumference is discernible, as the church has since become a mosque, and the Turks have built it up by masonry work. The choir towards the east forms a semicircle, the ends of which rest on two thick semicircular buttresses. Between these two semicircles, the apsis is supported by six other buttresses, which are divided by mouldings.

The interior of the Cathedral of Nikosia affords less interest than the exterior. It is divided into three naves by two rows of cylindrical columns, the main nave in the middle being nearly twenty mètres broad; the lateral naves ten mètres broad, surround the choir. The number of columns is sixteen; twelve of stone, opposite to the buttresses and the lateral naves, and four of granite around the choir. In the naves there is no trace of wood-carving, neither is there in the altar, pulpit, baptistery, &c. Under the mats and carpets — with which the Turks have covered the whole area—parts of the old stone floor, with numerous French inscriptions and sepulchral tablets are yet to be seen.

The granite columns around the choir have cylindrical capitals. Large leaves, resembling the ancient lotus, expand into scrolls, out of which ivy and vine are projecting. Their ornamentation reminds us of the Corinthian order, as also in the whole combination a tendency towards the antique is unmistakeable. The capitals of the other columns approach the Tuscan and Doric orders. Thus, Sta. Sophia exhibits a strong admixture of classic style, while our capitals of the buildings of the 13th century have already considerably abandoned that character.

Around the central nave runs a small terrace at the height of the columns, which, from distance to distance, is interrupted by staircases. While in most other churches of that date the façade is ornamented by a great rose window, the whole front of the central nave of Sta. Sophia is composed of one large window, which is divided into three compartments, extending from the vault to the top of the door. Six painted windows, covered by an archivolt, occupy the lower story.

Such are the main features of the Cathedral of Cyprus. But if we wish to have an idea how it appeared under the Lusignan Kings, or even under the sway of the Venetian Republic, we must abstract the wooden hoardings and walled-up windows of the Turks, and replace them by stained glass windows. It cannot be supposed, that at an epoch when this brilliant kind of ornamentation pervaded all great works of church architecture, the Cathedral of this kingdom should have been without it; and there are remnants of green and blue glass to be found in the large windows of the second story. The columns of the Cathedral are painted with a white oil-colour up to their capitals, which are relieved by the application of green, yellow, and blue. It is, however, evident that this paint has been either put on recently, or at least renewed; but whether under their present covering another coat of paint exists, could not be ascertained.

## LIGHTNING CONDUCTORS FOR SHIPS.*

By R. B. Forbes.

I have long considered a good lightning conductor for ships a great desideratum, and have employed a good deal of my spare time and money in endeavouring to introduce into our navy, and into our mercantile marine, the conductor of Sir William Snow Harris, which, in the British navy, in the Honourable East India Company's service, and in some of the other navies of Europe, has been adopted; every ship in the British navy has Harris's conductor, and not a pound sterling nor a single life has been lost by lightning since it has been fully adopted. This is a fact which speaks to the humane as well as to that no smaller class who look solely to their own interest.

The Harris conductor has not been used in our navy principally because "there is no appreciation in the navy department for the purchase of a patent right," and it has not been introduced into our mercantile marine because it is too costly.

With a view of bringing into use the same principles at a smaller cost, I turned my attention to a modification of Harris's conductor, and have obtained a patent for it. It consists simply in leaving the masts at or near to the eyes of the lower rigging, and coming down by one of the shrouds on each side, by a system of tubes and sockets in connection with a conductor fixed to the side of the ship. By this process the interior of the ship is avoided, and a simple yet fixed conductor is applied by which the electric fluid is carried off; a ship can be fitted as well afloat as on the stocks, and as well loaded as when empty, and the moderate cost brings it within the range of the *general ideas* of shipowners.

The usual chain or link conductor used in the navy, and in some merchant ships, is good *as far as it goes*, but being very liable to derangement, by reason of the strains and jerks to which it is subject, it is not generally adopted, and does not meet the requirements of a permanent conductor. A copper wire of $\frac{1}{16}$-inch in diameter, is good as far as it goes too, and the same may be said of a wire no larger than a piece of twine, or not larger than sewing silk. A small wire will carry off a small discharge of electricity harmlessly to the mast and ship, but it will fuse in the operation, leaving the mast unprotected. Now, it is desirable to have a conductor permanently fixed to, and incorporated with, the masts and hull of a ship, so that a heavy discharge will be as easily carried off as a small one by a small wire. The conductor which I have patented will do this if it has sufficient surface, and is thoroughly fitted.

I am now only waiting until I can make suitable arrangements with some well-known concern engaged in the manufacture of copper, for the purpose of supplying ships with fixed and reliable conductors, which, if generally adopted, will save many lives and much property.

The underwriters of New York have agreed to make a return of two per cent. of the premium on all ships furnished with suitable lightning conductors; they show a regard for the cause of humanity and for their own interests by making this return; and it is to be hoped that all underwriters will follow this good example. Not that it is the duty of underwriters to encourage these means more than shipowners, but the concession will have the effect to wake up the owners of ships to a sense of their duty in this respect.

* From the 'Scientific American.'

## NOTES OF THE MONTH.

*The General Board of Health.*—Mr. Tom Taylor, barrister-at-law, has been appointed Secretary to the Board, with a salary of 1000*l.* per annum; and Mr. J. F. Campbell, barrister-at-law, Assistant-Secretary, at 600*l.*; Mr. H. Austin, C.E., Consulting Engineer, at 1000*l.*; Mr. Ranger, C.E., Superintending Inspector, at 800*l.* Mr. Rammell and Mr. R. Rawlinson, late Superintending Inspectors, were offered appointments; and have declined. There are to be two Superintending Inspectors. One appointment remains to be made.

*District Surveyor to Parish of Hammersmith.*—Mr. Robert Garland, of Thames Chambers, Adelphi, has been elected by the Magistrates of the County of Middlesex to this office, rendered vacant by the death of his late partner, Mr. James Charles Christopher.

*The Ordnance Survey, Ireland.*—Colonel Hall, R.E., the head of the Ordnance Survey, has been succeeded by Major James at Southampton. Colonel Tucker, late commanding in Dublin, having retired, Captain Leach, now stationed in the Belfast, succeeds him. Captain Barlow, from Enniskillen, succeeds Captain Leach in Belfast. Lieutenant Parsons, from Glasgow, succeeds Captain Barlow at Enniskillen. Captain Leach is now accordingly the senior officer of the Ordnance Survey, Ireland.

*Merthyr Local Board of Health.*—Mr. Henry has been elected Surveyor to the Board, and is to have a salary of 250*l.* a year. There were thirty-two applicants.

*Rio de Janeiro.*—Mr. W. G. Ginty, formerly the Engineer and Manager of the Hydro-Carbon Gas Company, in Manchester, has since his arrival in Rio de Janeiro (to which city he went as Engineer to the Rio de Janeiro Gas Company), received two other appointments. The first is that of Engineer to the New City Canal, and the other that of Engineer to the Praia Grande Gas Company.

*Quicklime in Scotland.*—A large mountain, Zore-More, near Applecross, on the west coast, on being accidentally excavated, presented a substratum of pure quicklime, within five feet of the surface; and by a further excavation, it was ascertained that the whole mountain, except an average surface of 20 feet, consists of lime fit for building and agricultural purposes. On the summit volcanic remains have been found.

*A Willow Dock.*—Such a dock is now being built at La Crosse, Michigan. It is constructed entirely of willow twigs, about 12 feet long, bound in bundles one foot thick, which are so ingeniously arranged and woven together that it is impossible for sand to work out or the water to work in. Each bundle contains about 100 small trees, and it will take 50,000 of these bundles to complete the work. It is said that the willows will sprout and grow, rooting firmly together, thereby forming a living superstructure which will last for ages without the least tendency to decay. Docks like these occur very frequently on the banks of the Rhine in Germany.

*Labourers' Cottages.*—The Bath and West of England Agricultural Society has awarded the premium for the best plans and specifications of labourers' cottages to Mr. Leversedge, of Taunton.

*The Electric Gas.*—The works at Paris are progressing most favourably under the personal inspection of Mr. Shepard, and in a short time this valuable invention will be fairly tested on a large scale at the Hotel des Invalides. The fittings-up are said to be on a most extensive and magnificent scale. Its recommendation for cheapness has been proved at the Napoleon Docks, the works being carried on night and day, and the cost being under one halfpenny per man.

## NEW PATENTS.

### PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAW AMENDMENT ACT.

*Dated May* 10.

1046. J. Shepherd, Manchester—Improvements in compound steam-engines

*Dated May* 22.

1133. B. W. Fase, Charles-street, Soho-square—Improved construction of brooch for fastening dresses

*Dated May* 26.

1177. J. Lord, Farnworth, Lancaster—Improvements in the manufacture of articles of ladies' under clothing

*Dated May* 29.

1189. W. Northern, Vauxhall-walk, Lambeth—Improvements in the manufacture of mangers and troughs for stables

*Dated May* 30.

1193. R. Tomlinson, Sale, Chester—Application of a new material or fabric to the manufacture of plasters for medical or surgical purposes

*Dated June* 3.

1235. J. Renton, Bond-street, Vauxhall, and H. Attwood, Holland-street, Blackfriars—Improvement in the manufacture of starch, applicable in part to the solidifying of colours and other substances held in solution or suspension

*Dated June* 5.

1250. L. Brockelbank, Willesden—Improvements in manufacturing lubricating matters

*Dated June* 10.

1281. J. Braithwaite, Gower-street—Improved method of roofing or covering buildings, reservoirs, and other spaces requiring roofs or coverings

*Dated June* 19.

1328. T. M. Fell, King William-street, and W. Cooke, Curzon-street, Hanover-square Improvements in bottles and bottle-stoppers, and in stopping and applying the same

*Dated June* 21.

1358. H. Dembinski, Rue Joubert, Paris—Improvements in heating apparatus

*Dated June* 30.

1438. J. M'Gaffin, Liverpool—Improvements in the manufacture of iron casks and cisterns

*Dated July 1.*

1443. T. R. Harding, Leeds—Improvements in the manufacture of the pins of hackles, combs, and cylinders, used in hackling, combing, and preparing wool, flax, and other fibrous substances, and in the mode of applying them to manufacturing purposes

*Dated July 5.*

1478. J. Venables and A. Mann, Burslem, Stafford—Printing self and other colours in bas-relief or raised work on china, earthenware, glass, parian, stoneware, bricks, blocks, tiles, quarries, hardware, japan, and papier-mache ware

*Dated July 6.*

1479. S. Harvard and J. Womersley, Stoke Holy Cross, Norfolk—Heating crushed seed for making cake, for drying seeds, corn, and other grain, and for feeding mill-stones or other grinding apparatus

1481. J. Arrowsmith, Bilston, Stafford—New or improved method of consuming or suppressing smoke and obtaining motive power therefrom

1483. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in apparatus for breaking in horses. (A communication)

1487. J. H. Johnson, Lincoln's-inn-fields—Improvements in machinery or apparatus for effecting agricultural operations; parts of the said improvements being applicable for the obtainment of motive power for general purposes. (A communication)

1489. J. E. M'Connell, Wolverton, Bucks—Improvements in wheels, axle-boxes, and breaks for railway-carriages

1491. W. Pole, Storey's-gate, Westminster—Improvements in the construction of railways

*Dated July 7.*

1493. W. Lacey, Lozell's-lane, Aston-juxta-Birmingham—New or improved method of making copper rollers, cylinders, and tubes

1494. A. Morison, Inchmichael, Perth—Improved mode of protecting or preserving agricultural and horticultural produce from disease or blight

1495. G. Beard and W. Beard, Cannon-street—Improved needle-depositor

1496. J. Ross, Keighley, York—Improvements in making compounds of chocolate, cocoa, and other ingredients for breakfast, and occasional beverages

1497. A. V. Newton, Chancery-lane—Improved construction of pump for raising and forcing fluids. (A communication)

1498. J. L. Norton, Holland-street, Blackfriars—Improvements in turnstile counting apparatus

1499. J. Ellisdon, Liverpool—Improvements applicable to reading, lounging, and other chairs

1500. H. R. Cottam, Argyle square, King's-cross—Improvements in horse-mangers

*Dated July 8.*

1501. T. Waller, Ratcliff—Improvements in the construction of stoves and other fireplaces

1502. W. Robinson and R. Crighton Manchester—Improvements in machinery or apparatus for rolling metal into suitable shapes or forms

1503. L. Tindall, Scarborough—Improvements in bruising or reducing grain and other substances

1505. Hon. J. Sinclair (commonly called Lord Berriedale), Hill-street—Improvements in the manufacture of paper, and in the production of textile materials

1506. F. L. Bauwens, Pimlico—Improvements in the manufacture of soap

1507. T. S. Whitworth, Salford, Lancaster—Improvements in machinery or apparatus for cutting or shaping wood; parts of which are particularly applicable in the construction of spinning machinery

1508. E. Lord, Todmorden, York—Improvements in machinery for cleaning and carding cotton and other fibrous materials

*Dated July 10.*

1509. D. Beck, Carlton House, Southampton—Improvements in brewing and distilling

1510. S. M. Saxby, South Lambeth—Improvement or improvements in making fast and letting go the cords of window-blinds; which said improvement or improvements may also be applied to the fastening and letting go of ropes, cords, lines, wires, and chains for various other purposes

1511. I. Swindells, Manchester—Improvements in the treatment of wood and vegetable matters for the production of vegetable fibre

1512. G. A. Biddell, Ipswich—Improvements in machines for cutting vegetable and other substances

*Dated July 11.*

1514. E. Wolverson, Aston-juxta-Birmingham—New or improved lock

1516. M. Walker, Horsham, Sussex—Improved construction of cooking-stove

1517. T. R. Harding, Leeds—Improved mode of doffing fibrous materials from hackle cylinders, and gill or porcupine or preparing rollers

1518. C. F. Moore, Portswood-park, Southampton—Improvements in the construction and use of an apparatus, closet or receptacle, to be used instead of a watercloset or other necessary, and which may be either fixed or portable

1519. V. G. A. Cuvier, Seloncourt, France—Improved apparatus, having for its object the combustion of fuel and the utilisation of the gaseous products for heating and other useful metallurgic purposes

*Dated July 12.*

1521. W. Houghton and R. Hoyle, Lancaster—Improvements in machinery for spinning and doubling cotton and other fibrous substances

1522. F. A. Gatty, Accrington, Lancaster—Improvement in the manufacture of printed receipt stamps

1523. M. Townsend, Leicester—Improvements in the manufacture of knitted fabrics

1524. O. Maggs, Bourton, Dorset—Improvements in thrashing-machines

1525. L. Cooke, Sowerby-bridge, York—Improvements in machinery or apparatus for preparing cotton, wool, or other fibrous substances to be spun

1526. J. Knowelden, Church-road, Battersea—Improvements in steam-boiler and other furnaces

1527. T. E. Moore, St. Marylebone—Improvements in apparatus to be used for extinguishing fires

1528. R. Armstrong, Hall-street, City-road, and J. B. Dew, Pentonville—Improved apparatus for consuming smoke

1529. A. J. Loiseau, Paris—Improvements in manufacturing fringes and other plaited fabrics

1530. J. T. Marshall, New York—Improvements in reefing, and furling the sails of ships or other vessels

1532. J. Robertson, Kentish-town—Improvements in the consumption or prevention of smoke

1533. C. D. Gardissal, Boulevard St. Martin, Paris—Stamp-safe

1534. A. E. L. Bellford, Castle-street, Holborn—Improvements in preserving animal substances. (A communication)

*Dated July 13.*

1535. W. Flitcroft, Bolton, Lancaster, and T. Evans, Manchester—Improvements in printing and finishing floor-cloths, or any other fabrics or materials printed in oil colours. (A communication)

1536. A. J. Lane, Surbiton, Surrey—Improvements in breech-loading fire-arms

1537. T. B. Foulkes, Chester—Improvements in the manufacture of self-adjusting gloves

1538. J. Greenwood, Irwell Springs, near Bacup, and R. Smith, Bacup, Lancaster—Improvements in sizeing, stiffening, and finishing textile materials or fabrics

1539. L. Lawson, Paris—Improvements in printing

1540. E. Travis, Oldham, Lancaster—Improvements in machinery or apparatus for indicating and registering the height of water, and also the pressure of steam in steam-boilers or generators

1541. J. Hackett, Derby—New method of fastening the ends of india-rubber elastic cord, and india-rubber elastic web

1542. R. Bodmer, Thavies-inn, Holborn—Application of glass, crystal, or other vitreous material, or of earthenware (ceramique) to certain parts of machinery. (A communication)

1543. J. B. Chauvet, jun., Aix, Provence—New system of anchor

*Dated July 14.*

1545. A. S. Stocker, Poultry—Improvements in axles

1546. W. Bishop, Boston, Lincolnshire—Improvements in machinery or apparatus for ticketing or labelling spools, parcels of the same, or other similar parcels

1547. C. Sewell, Lougton-lodge, Longton-grove, Sydenham—Improvement in spring-hinges for doors and gates

1548. M. Wiburg, Myddleton-square—Improvements in the construction, setting-up, and distribution of types for printing

1549. J. McGaffin, Liverpool—Improvements in the mode of corrugating angular iron

1550. J. McGaffin, Liverpool—Improvements in the construction of iron bridges

1551. J. Derham, Bradford, York—Improved machinery for combing wool and other fibrous substances

1552. A. P. Price, Margate—Improvements in the distillation of wood and of other vegetable substances

1553. J. B. Dechanet and A. D. Sisco, Paris—Improvements in the construction of railway carriages

*Dated July 15.*

1554. E. H. Briadley, Longton, Stafford—Improvements in printing or ornamenting china, earthenware, and glass

1555. J. Taylor, Burnley, Lancaster—Improved clothes-peg. (A communication)

1556. R. Waller, Manchester—Improvements in the manufacture of letters and figures, and of ornamental signboards and other tablets, and in affixing letters, figures, or ornaments to glass

1557. F. V. Guyard, Gravelines, France—Improvements in the electro-telegraphic communications for preventing mischances during the passage of trains on railways

1558. T. Wright, George-yard, Lombard-street—Improvements in the permanent way of railways

1559. J. Ashworth, Turton, Lancaster—Improvements in apparatus to be employed in the construction of the permanent way of railways

1560. T. Summerfield, Birmingham—Manufacture of chromatic glass and glass-faced bricks, which said bricks are applicable to face-work or fronts of buildings, basements, pilasters, stringcourses, door and window heads, modillions, cornices in part or whole, or other purposes where a superior finish and durability are required; a part of which is also applicable to bricks made wholly of clay

1561. W. Hunt, Tipton, Stafford—Improvements in utilising certain compounds produced in the process of galvanising iron, and in the application of the same and similar compounds to certain useful purposes

1562. G. W. Kelsey, Hope Farm, near Folkstone, Kent—Improvements in air-engines

1563. M. F. Wagstaffe, Walcot-place, Lambeth, and J. W. Perkins, Poplar-terrace, Poplar—Improvements in obtaining metals from ores and oxides

1564. J. Spires, Cleveland-street, Fitzroy-square—Improvements applicable to boots and shoes

*Dated July 17.*

1565. J. B. Denton, London—Improved hoes and spuds

1566. T. M. Woodyatt, Kinver Mills, Stafford—Improvement or improvements in consuming or suppressing the smoke of steam-engine boiler and other furnaces

1567. G. North, Lewisham-road, Kent—Improved apparatus to be attached to garments for protecting watches, purses, and other articles from being stolen from the person

1568. W. Warcup, Lyndhurst-villa, Coronation-road, Bristol—Improvements in the construction of springs for carriages and similar purposes

1569. J. Lockhart, Paisley, Renfrew—Improvements in the manufacture of bobbins

1570. J. Fowler, jun., Temple-gate, Bristol—Improvements in draining ploughs

1571. J. Livesey, New Lenton, Nottingham—Improvements in lace machinery, and in fabrics manufactured by such machinery

*Dated July 18.*

1572. J. Barlow, Accrington, Lancaster—Improvements in the mode or method of extracting gluten from wheat or flour, and preparing the residuum for sizeing purposes

1573. H. Hitchins, King William-street, and W. Batley, Dean-street—Combinations of materials suitable for mouldings and medallions, and to be employed as a substitute for wood, gutta-percha, and other like materials

1574. M. C. Hill, Dublin—Improvement in bonnets and in bonnet-frames

1576. R. Hornsby, Grantham, Lincoln—Improvement in the straw-shaking apparatus of thrashing-machines

1577. A. E. L. Bellford, Castle-street, Holborn—New kind of piston. (A communication)

1578. G. Twigg and A. L. Sylvester, Birmingham—Improvements in apparatus or machinery for stamping or pressing metals

1579. P. Cato, Liverpool—Improved trough or manger for holding the provender of horses, cattle, and other animals

1580. W. B. Johnson, Manchester—Improvements in steam-engines

1581. A. Dalgety, Florence-road, Deptford—Improvements in the reduction of friction

1582. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in zincography. (A communication)

1583. S. Mitchell, Dewsbury, York—Improvements in the manufacture of cards for carding wool, cotton, silk, and other fibrous materials

*Dated July 19.*

1584. J. C. Brown, Cheltenham—Improvements in the manufacture of camp-bedsteads

1585. J. Whiteley, J. Slater, and W. H. Crossley, Halifax, York—Improvements in machinery or apparatus for preparing and spinning wool and other fibrous substances

1586. J. Longley, Hunslet-road, Leeds—Machine for turning and finishing tubs, pails, casks, and other wooden vessels of an elliptic, oval, or other eccentric form

1587. W. Ball, Rothwell Kettering, Northampton—Improvements in drills

1588. M. Mitchell, Stoke Newington—Improvement in furnaces having for object the consumption of smoke

1589. F. H. Wenham, Effra-vale, Lodge-bridge, Brixton—Improvements in steam-engines

*Dated July 20.*

1590. J. Sudbury, Halsted, Essex, and S. Wright, Clare, Sussex—Improvements in taps and valves, and in the method of working them for the purpose of regulating the passage of fluids

1591. R. Roberts, Manchester—Improvements in machinery for preparing to be spun cotton and other fibres

1592. J. B. Gillet, Adge (Herault), France—Improvements in capstans, winches, and windlasses

1593. G. Jackson, Manchester—Improvements in the construction of tents

1594. J. Barnes, Church, Lancaster—Improvements in furnaces or fireplaces

1595. F. Whitehead and W. Whitehead, Crayford, Kent—Improvements in safety-lamps

1596. J. Hackett, Derby—Covering india-rubber thread, whether vulcanised or otherwise, with sewing-silk, and with other articles
1597. W. Palliser, Comragh, Waterford—Improvements in projectiles for fire-arms and ordnance generally

*Dated July 21.*

1598. T. Chambers, jun., Colkirk, Norfolk—Improvements in machinery for distributing manure
1600. T. Delabarre and L. Bonnet, Grenelle, Paris—Preservation of meat in its natural state, and without being cooked
1601. A. B. J. Jean and A. A. Hugues, Paris—Improvements in reducing the friction of axles, bearings, or other rotatory rubbing surfaces in machinery
1602. A. V. Newton, Chancery-lane—Improved construction of metallic spring. (A communication)
1603. J. T. Moss, Arundel-street, Strand—Improvements applicable to apparatus for roasting meat and other edible substances
1604. J. Knight, Birmingham, and J. Stubbs, Oldbury, Worcester—Improvement or improvements in the manufacture of bricks, tiles, pipes, and such other articles as are or may be made of clay; which improvement or improvements may also be applied to the manufacture of artificial fuel, and to other mixing and tempering processes
1605. I. Alexandre and A. Sommerville, Birmingham—Improvement or improvements in boots and shoes, and in socks or inner soles for boots and shoes
1609. J. Sedgwick, Lewisham, Kent—Improvements in shipbuilding
1610. M. A. Stevens, West Derby-street, Liverpool—Improvements in bonnets
1611. C. Harratt, Royal Exchange-buildings—Improvements in fastenings for shipbuilding
1612. H. Francis, Strand—Improvement in feeding fuel on to the fire-bars of boiler and other furnaces

*Dated July 22.*

1613. J. Lamb, Newcastle-under-Lyne, Stafford—Improvements in or applicable to machines for making paper. (A communication)
1614. T. Firth, Huddersfield, and J. Wilson, Mirfield, West Riding—Improvements in finishing woollen, worsted, silk, and other woven fabrics, and in the apparatus employed therein
1615. J. H. Young, College-street, Camden-town—Improvements in gathering grain and other crops, and securing the same
1616. W. S. Losh, Wreay Syke, near Carlisle—Improvements in bleaching
1617. J. Bainbridge, Ely-place, Holborn—Improvements in fire-grates, stoves, furnaces, and other similar contrivances
1618. W. Johnson, Lincoln's-inn-fields—Improvements in the treatment, cleansing, and dyeing of fibrous and textile materials. (A communication)
1619. J. Dilks, Parliament-street, Nottingham—Application of printed or painted linen, cotton, or other textile fabric, either plain or ornamental, for binding more effectually than heretofore packets or parcels of lace, hosiery, or other articles

*Dated July 24.*

1620. R. F. Hutchins, Whitechapel-road—Constructing the cylinders or engines worked by steam, air, or other fluid body, in a circular form or plan, by which means more power is obtained from a given quantity of the said fluid body in cases where a circular motion is required than by any other known form of cylinder
1622. J. H. Johnson, Lincoln's-inn-fields—Improvements in the preparation of silk. (A communication from C. L. A. Williott, St. Quentin, France)
1624. G. F. Wilson and G. Payne, Belmont, Vauxhall—Improvements in distilling fatty and oily matters
1625. A. E. L. Bellford, Castle-street, Holborn—Improvements in kneading-machines. (A communication)
1626. B. Cole, jun., Deardsend, Hertford—Improved agricultural machinery or apparatus for ploughing and grubbing

*Dated July 25.*

1627. F. Preston, Manchester—Improvements in machinery for preparing cotton and other fibrous materials
1629. W. Grundy, Bury, Lancaster—Improvements in the manufacture of drugget. (A communication)
1630. E. Hallum, Steckport—Improvements in machines for preparing, spinning, and doubling cotton and other fibrous substances
1632. P. Spence, Pendleton, Lancaster—Improvements in obtaining sulphur from iron pyrites and other substances containing sulphur, and in apparatus for effecting the same
1633. T. Bell and H. Scholefield, South Shields—Improvements in the manufacture of borax
1634. W. S. Garland and J. Glasson, Stafford—Means of consuming smoke in furnaces
1635. J. C. Hurd, Medway, Worcester, U. S.—Improved machine and process for picking, burring, and cleaning cotton, wool, and for tearing up and reducing old fabrics to be re-spun
1636. J. McGaffin, Liverpool—Improvements in constructing and applying heads to metal casks and vessels

*Dated July 26.*

1637. J. Lamacraft, Westbourne-grove—Improvements in envelopes or means for securing letters, notes, and similar documents
1638. J. A. Cutting, Boston, U. S.—Improved process of taking photographic pictures upon glass, and also of beautifying and preserving the same
1639. W. Church and S. A. Goddard, Birmingham—Improvement or improvements in ordnance
1640. A. Oppenheimer, Manchester—Improvements in the manufacture of mohair velvet or mohair plush, and worsted velvet or worsted plush
1641. J. C. Purnelle, Tachbrook-street, Pimlico—Improvements in obtaining and applying motive power
1642. A. E. L. Bellford, Castle-street, Holborn—Improved mill for grinding paint and other moist substances. (A communication from C. W. Brown, Boston, U. S.)
1643. L. C. Koeffler, Rochdale, Lancaster—Improvements in finishing or polishing yarns or threads
1644. E. A. Pontifex, Shoe-lane, and C. Glassford, Ashburnham-grove, Greenwich—Improvements in obtaining soft lead from hard lead, for the separation of the impurities in hard lead, and for the separtion of antimony from these impurities
1645. T. Huckvale, Choice-hill, near Chipping Norton—Improvements in machinery for gathering crops
1646. P. A. Godefroy, King's Mead Cottages, Islington—Improvements in purifying coal, naphtha, and turpentine
1650. A. E. L. Bellford, Castle-street, Holborn—Improvements in soldering metals. (A communication)

*Dated July 27.*

1651. G. Mumby, Hunter-street, Brunswick-square—Improvements in bearings, and in the prevention of friction
1652. R. C. Burleigh, Northumberland-street, Charing-cross—Improvements in guns, and in the shot or other projectiles fired therefrom
1654. F. D. Molvé and P. Martin, Paris—Improvements in heating water for feeding boilers of locomotives and marine steam-engines
1655. S. Varley, Stamford, Lincoln—Improvements in the construction of reaping machinery
1656. W. Shorrocks, Farnworth, Lancaster—Improvements in presser-flyers for preparing cotton and other fibrous substances for spinning
1657. S. Frankham, Greenland-place, Judd-street—Improvement in the construction of furnaces
1658. B. H. Jenks, Bridesburg, U. S.—Improving the art of weaving, being an improvement in looms for weaving fancy fabrics
1659. H. Wickens, Tokenhouse-yard—Improvements in the means of giving signals on railways, and for other purposes
1660. N. Miller and R. Graham, Guide-bridge, Lancaster—Improvements in the construction of certain parts of the permanent way of railways, commonly called crossings
1661. A. Law, Glasgow—Improvements in cranes, or lifting and lowering apparatus

*Dated July 28.*

1662. G. L. Scott and S. Bennett, Manchester—Improvements in springs for pressing together rollers for mangling and other purposes
1663. A. Guild, Salford, and J. Pendlebury, jun., Manchester—Improvements in apparatus for scouring or bleaching
1665. R. Johnson, Manchester—Improvements in coating and insulating wire
1666. F. Morton, Liverpool—Improvements applicable to girders or rafters to be used in the construction of roofs, bridges, buildings, and other erections
1667. A. H. Petit, Paris—Improved mode of joining pipes
1668. S. Clift, Manchester—Improvements in making paper, pasteboard, and papier-mache
1669. J. Gilbertson, Hertford, Herts—Improvement in supplying air in furnaces

*Dated July 29.*

1670. R. J. Keen, Liverpool—Improvements in the mariner's compass
1672. E. Burke, Upper Thames-street, and A. S. Stocker, Poultry—Improvements in the manufacture of metallic tubes and such like articles
1674. W. H. Smith, Bloomsbury—Improvements in the permanent way of railways
1675. G. E. B. Collasson—Improvements in the means of arresting or checking the progress of trains on railways. (A communication)
1676. J. Y. Bourland, Manchester—Improvements in machinery for preparing and spinning fibrous materials
1677. J Fawcett, Gateshead, Durham—Apparatus for regulating and economising the consumption of gas generally, but more particularly when employed for the purposes of illumination
1678. G. H. Ingall, Warnford-court, Throgmorton-street—Improvements in elastic bands for holding books and papers
1681. H. Walduck, Warwick-court, Gray's-inn—Improvements in propelling vessels
1682. G. Thatcher, Welton Midsomer Norton, Somerset—Improvements in the manufacture of woven fabrics, yarns, cordage, ropes, paper, and pasteboard, by the application of a material not hitherto used for such purposes

*Dated July 31.*

1684. H. Adams, Leonidas-terrace, Deptford—Revolving ventilator
1685. H. Green, Liverpool—Improved apparatus applicable to the hanging of doors, gates, and windows, and for closing or holding open the same when required
1686. J. Green and W. Jackson, Leeds—Improvements in mortising-machines
1688. T. R. Bridson, Bolton-le-Moors—Improvements in preparing cotton for manufacturing purposes

*Dated August 1.*

1689. E. Gillman, Twickenham—Improvements in the manufacture of papier-mache and other similar articles from certain vegetable substances
1690. J. F. Bouneau, Paris—Improvements in propelling ships
1691. T. Evans, jun. Belmont-terrace, Lewisham—Improvements in the rigging of ships and all other vessels using or carrying sails, whether propelled by steam or otherwise, or on whatsoever sea, river, or other water navigated
1692. C. R. Read, Moorgate-street—Improvements in slide-valves of steam-engines. (A communication)
1693. J. M'Gaffin, Liverpool—An improvement in the manufacture of sheet-metal pipes
1694. W. E. Newton, Chancery-lane—Improvements in the construction of repeating fire-arms. (A communication)
1695. R. A. Brooman, Fleet-street—Improvements in machinery for dressing flax, hemp, and other like fibrous substances. (A communication)
1696. T. E. Merritt, Maidstone—Improvements in apparatus for taking photographic pictures in the open air
1697. J. S. Holland, Woolwich—Improvements in locks

*Dated August 2.*

1698. J. Griffiths, Wickham market, Suffolk—A new or improved lever bit for horses
1699. S. Lees, Salford—Improvements in machinery or apparatus to used in purifying gas for illumination
1700. G. H. Palmer, Adelaide-road, Hampstead—Improvements in guns, gun carriage, and appurtenances, and in the manipulation or working of guns
1701. C. Chevron, Paris—Improvements in looms for weaving
1702. J. Brown, Stockport—Improvement in the method of consuming smoke
1703. P. G. de Seresina, Bedford-row—Improvements in treating flax and hemp

*Dated August 3.*

1705. W. Rye and W. Crowther, Oldham—Improvements in steam-engines
1707. W. Gossage, Widnes, Lancaster—Improvements in the manufacture of certain kinds of soap and other detergent compounds

*Dated August 4.*

1709. L. P. Miles, Ravensbourne-park, Lewisham—Improvements in the construction of locks.
1711. S. L. Taylor, Cottonend. Bedford—Improvements in constructing and arranging the beaters and dressing machinery of thrashing machines
1713. A. Kortright, James-street, Adelphi—Improvements in marine and surveying compasses

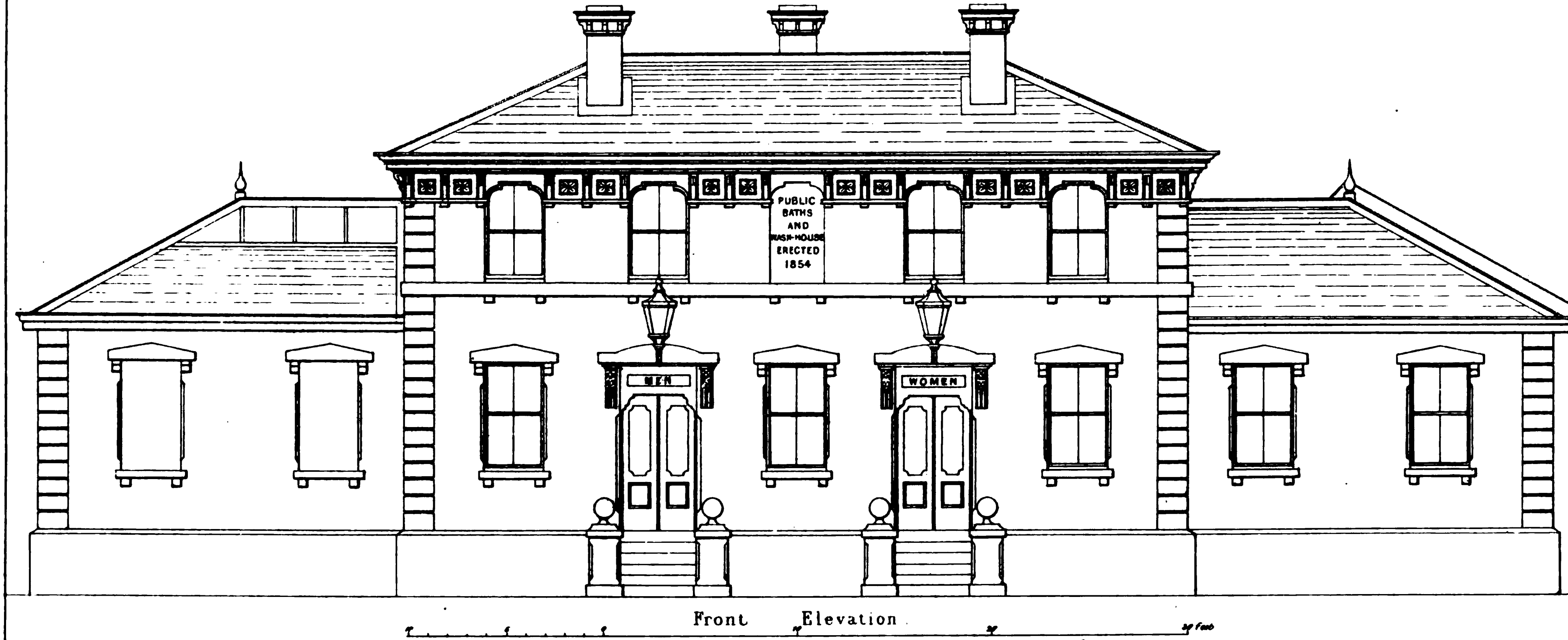
*Dated August 5.*

1715. A. Boissonneau, Paris—Improvements in artificial eyes.
1717. C. F. Stansbury, Cornhill—Improvements in locomotive and steam boiler furnaces. (A communication from J. Amory and W. Parrott, Boston, U.S.)
1719. C. F. Stansbury, Cornhill—Improved air-tight vessels. (A communication from R. Arthur, Washington, U.S.)
1721. J. Gathercole, Eltham, Kent—Improvements in bordering, or producing devices upon the edges of envelopes, letter paper, or other articles of stationery

## PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

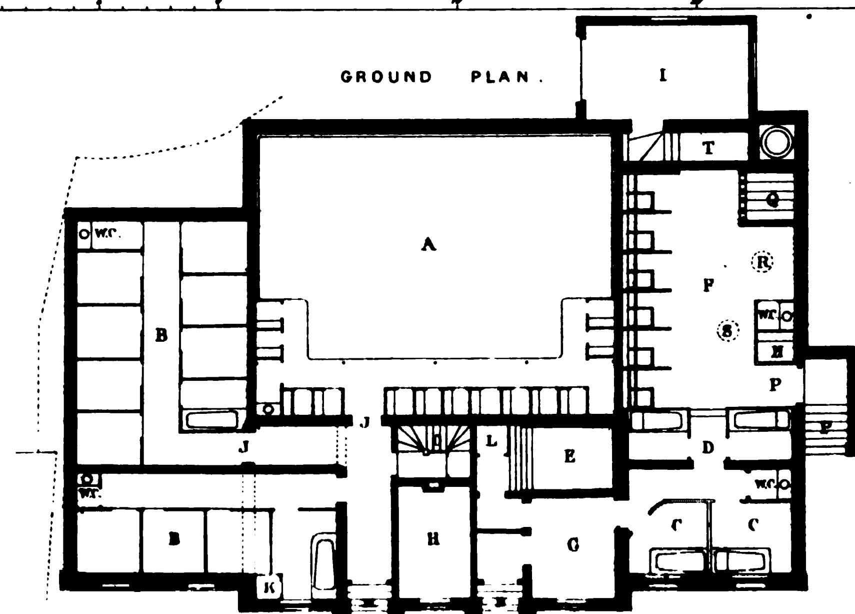
1606. N. Callan, Maynooth College, Kildare—A means by which iron of every kind may be protected against the action of the weather and of various corroding substances, so that iron thus protected will anwer for roofing, for cisterns, baths, gutters, window frames, telegraphic wires, for marine and various other purposes; and by which brass and copper may be similarly protected—July 21
1607. A. E. L. Bellford, Castle-street, Holborn—Improvements in breech-loading fire-arms.—July 21
1653. W. B. Caulfield, Cole Harbour, Blackwall—The manufacture of brushes to be used in cleaning the small tubes of steam-boilers, and for other purposes.—July 27
1671. P. G. Harris, Buckingham-street, Adelphi—Improvements in locomotive engines. (A communication.)—July 29
1673. E. Burke, Upper Thames-street—Improvements in instruments for withdrawing corks and in uncorking bottles.—July 29
1756. T. Lawrence, Birmingham—Improvements in the manufacture of bayonet blades, and in machinery or apparatus to be employed for that purpose—Aug. 11.

# KIDDERMINSTER BATHS & WASH HOUSES.




Front Elevation.

GROUND PLAN.



REFERENCE.

- A. *Swimming Bath.*
- B.B. *Mens Bath*
- C. *Ladies Bath*
- D. *Womens 2nd Class Bath.*
- E. *Plunge Bath*
- F. *Wash-house.*
- G. *Waiting Room*
- H.H. *Offices.*
- I. *Stokery*
- J.J. *Glass Doors*
- K. *Vapour Bath.*
- L. *Dressing Box.*
- M. *Mens Entrance*
- N. *Ladies D°.*
- O. *Stairs to Superintendents House.*
- P.P. *Entrance to Wash-house and Women's 2nd Class Baths.*
- Q. *Drying Closet.*
- R. *Macalpines Machine.*
- S. *Wringing Machine.*
- T. *Steps to Hot Air Apparatus*

ASHPITEL & WHICHCORD, Architects.

## KIDDERMINSTER BATHS AND WASH-HOUSES.

*(With an Engraving, Plate XXXIII.)*

The borough of Kidderminster contains a population of something under 20,000 souls, and the town council have adopted the Act for the Establishment of Public Baths and Wash-houses; and, after due consideration, have resolved to erect the building represented in our engraving, under the charge of Messrs. Ashpitel and Whichcord, as architects.

We have much pleasure in directing public attention to this building, inasmuch as, while providing the requisite accommodation for a town of moderate size, it is not so large and costly as to induce any fear of it being a burden upon the ratepayers. The unwieldy dimensions, and consequent cost entailed upon many towns, has been the means of paralysing the more general adoption of these valuable institutions; and we have not failed from the first to impress upon our readers the advisability of confining cost within moderate compass.

The Kidderminster plan entirely coincides with this view, and, as will be seen in our illustration, the elevation is neat and modest; but the material is good and substantial, the walls being red brick, and the dressings of the stone of the county, while the brackets and ornamental portion of the cornice are of terra-cotta.

The interior arrangements are, generally speaking, similar to the baths and wash-houses already erected by these architects. As usual, the centre is the pay-office, dividing the entrance for one sex from that of the other. There is one large swimming-bath, 38 feet by 30 feet, and twelve men's ordinary size baths, divided into two classes; also shower-baths and a vapour-bath. The ladies' department is entirely distinct, and consists of a waiting-room, two bath-rooms, and a plunge-bath. The wash-house is also distinct, and has a separate entrance. This part of the establishment is on a small scale. The detail of the arrangements comprise all those improved matters which experience has suggested. The baths are of porcelain (glazed), and the divisions of the baths of slab-slate; in short, all those little minutiæ have been strictly attended to which ensure purity and cleanliness for the bathers, rapidity and economy in the working of the machinery, and a careful attention to make every gallon of water and every ton of coals do their duty.

The building is one story in height, and is, of course, lighted and ventilated from the roof, which is partly of glass. The centre building over the office and waiting-rooms is an exception, being carried up so that the first-floor is the residence of the superintending officer.

The cost of this building, with all its fittings and machinery, will not exceed 2500*l.*

From the best data furnished in reference to the working of these institutions, we may fairly presume that not only will such an establishment be self-supporting, but, if worked with care and judgment, prove to be remunerative. In towns of similar size to Kidderminster, it is found the weekly number of bathers is 1100 in summer, and 450 in the winter months. This is a low average, and would give 775 bathers a week throughout the year. The scale of charges varies from 6*d.* first-class to 2*d.* for a second-class warm bath. Taking the average at 4*d.*, gives a return of 12*l.* 18*s.* 4*d.*, which, with the small amount from the wash-house, would raise the average weekly returns to 14*l.* The expenses would be as follows:—

| | Per annum. £ s. d. | Per week. £ s. d. |
|---|---|---|
| Wages of staff: | | |
| Superintendant and matron, being also money takers — House, &c. | 80 0 0 | |
| Stoker, mechanic | 65 0 0 | |
| Boy to assist | 19 10 0 | |
| First male attendant | 41 12 0 | |
| First female attendant | 39 0 0 | |
| Total wages | 245 2 0 | 4 10 0 |
| Coals, 200 tons | 80 0 0 | |
| Gas | 25 0 0 | |
| Washing towels | 13 12 6 | |
| Printing and stationary | 15 0 0 | |
| Mops, brushes, and brooms | 15 0 0 | |
| Taxes and sundries | 50 0 0 | |
| | 198 12 6 | 3 16 0 |
| Total cost per week | | £8 6 0 |

Which, being deducted from the returns, would give an excess of receipts over expenditure of 5*l.* weekly, or something like 10 per cent. We have much pleasure in being able to offer the above calculations, as they are the result of existing facts.

No one now doubts the value of these salutary institutions; and the only reason we can conceive why they have not become more general, is the fear of rates and consequent opposition of ratepayers. But experience has now proved, that where due economy is used in the first erection; where the machinery and fittings are durable and of the most appropriate kind, and, consequently, the most economical; where the buildings are so contrived that the least amount of attendants' labour is required; and where careful attention has been given to those parts of the establishment implying the daily consumption of coal and water, so as to ensure the best machinery for the economical use of both,—when these matters are attended to, and done well, then there is no doubt of entire success.

## THE HOUSES OF PARLIAMENT.

*Tenth Report of the Commissioners on the Fine Arts, to the Queen.*

The series of eight Fresco-paintings in the Upper Waiting Hall is now completed. In first proposing that the apartment should be decorated with paintings executed in that method, we observed, viz., in our report of the 7th of August 1845, that we were "desirous to afford opportunities for the further practice of Fresco-painting, and for the cultivation of the style of design which is fitted for it, * * * provided the architectural arrangements and the light should, on the completion of the apartment, be found to be adapted for the purpose." The room was ultimately found to be but scantily lighted, but we conceived that, as the paintings would admit of being closely inspected, that objection was in itself less important; while, on the other hand, it might not be without its use experimentally, by suggesting a treatment adapted to such a condition.

We have now to add that, apart from the important objects, more or less attained in the designs referred to, of appropriate conception and expression in reference to the subjects, these experimental works will be of use in showing what are the external qualities generally essential in Fresco-painting, and especially so under given local circumstances. It will be for artists to consider, in witnessing the effect of these works, to what extent the great requisite of distinctness, as resulting, in its perfection, from intelligible forms, perspicuous arrangement, and the judicious distribution of light and dark masses, has or has not been kept in view, subject to the local conditions of light, the size of the apartment, and the dimensions of the paintings; and subject to the general technical conditions of Fresco-painting, —a method requiring, from its comparatively limited resources, an especial attention to simplicity and significance in representation.

In the House of Lords, eleven of the eighteen metal statues of Barons and Prelates are now placed in the niches intended to receive them. The seven remaining statues are the only works, coming under our superintendence, now to be completed for this chamber.*

In St. Stephen's Hall, without as yet contemplating the execution of the Frescoes intended for that locality, we propose that the series of twelve marble statues of eminent statesmen named in our fourth report, bearing date the 25th of April 1845, should be gradually completed. Accordingly, in addition to the three already executed and placed in the Hall, we have given commissions to five artists to execute each a statue of one of such personages.

With regard to the Prince's Chamber, which we propose to decorate with statues, bas-reliefs, and other works, as detailed in our seventh report, dated the 13th July 1847, we have commissioned John Gibson, R.A., to execute a statue of your Majesty, with figures of Justice and Clemency, and with bas-reliefs on the pedestal, to be placed in the recess on the north side of the apartment. We have also employed Mr. William Theed to prepare a series of bas-reliefs, to be subsequently cast in metal, for the panels on the walls.

Of the Frescoes intended for your Majesty's Robing Room, undertaken by William Dyce, R.A., and illustrative of the

* See Journal, *ante* p. 85, for an "Account of the Amount of all Commissions for Works of Art to various Artists for the Decoration of the New Palace of Westminster, from its commencement to the present time."

Legend of King Arthur, as proposed in our seventh report, four have been completed. As it appears that the artist will now be enabled to devote his whole time to these works, they will, it is hoped, in future proceed more rapidly. With respect to the four paintings referred to, we consider them altogether satisfactory, whether regarded in their general treatment, or as examples of the method of Fresco-painting.

We have commissioned John Rogers Herbert, R.A., to prepare a series of designs for Frescoes to be executed in the Peer's Robing Room, according to a scheme also indicated in our seventh report. The room itself is not yet built, and it is therefore expected that the artist's designs will be completed by the time the walls are in a fit state to receive Frescoes.

We have also given our attention to the decoration of the principal corridors connecting the Central Hall with the two Houses of Parliament. We have accordingly commissioned Edward Matthew Ward, A.R.A., to undertake the Commons' Corridor, and Charles West Cope, R.A., to undertake the Peers' Corridor. The subjects intended for these localities are enumerated in our seventh report, in which it is also proposed that the pictures should be painted in oil.

We further propose to commission Daniel Maclise, R.A., to paint in fresco, in the Painted Chamber or Conference Hall, the subject of the marriage of Strongbow and Eva, the subject being one of the series selected by us for that apartment. The design for the Fresco so proposed to be executed will be adapted, according to the requirements of Fresco, from an oil picture of the same subject executed by the artist on his own account, and which he has treated with great ability.

In our last report, dated the 11th of March 1850, we stated that the Lords Commissioners of your Majesty's Treasury had consented to propose to Parliament an annual expenditure amounting to four thousand pounds to defray the cost of the various works recommended by us. Since that period we have, with the sanction of their lordships, continued to submit to Parliament an annual estimate accordingly. The limitation of the expenditure as stated may however be regarded as a cause of delay in the prosecution of some of the works.

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Lord Palmerston has notified that her Majesty approves of the Report, and has directed the Lords Commissioners of the Treasury to submit to Parliament estimates in conformity with the recommendations contained therein.

## ON THE EMPLOYMENT OF A SOLUTION OF STARCH IN FRESCO PAINTING.

By W. Dyce, R.A.

TO SIR C. L. EASTLAKE, P.R.A., SECRETARY FINE ARTS COMMISSION.

In some observations on fresco addressed by me to the Commissioners on the Fine Arts in 1846, and printed by them in their Seventh Report, I had occasion to refer to the difficulties experienced by fresco painters in the use of ultramarine and some other pigments; and I suggested that if a solution of starch or of the caseous element of milk were mixed with the colours, their adherence to the intonaco might probably be reckoned upon with certainty. This was a mere suggestion based on the known fact that both these substances form, with quicklime, a compound which, when it is dry, is insoluble in water.

Since that time, however, I have had ample opportunity of submitting one of the suggested expedients to the test of experiment, and the result has been so satisfactory that I think it desirable to put the commissioners in possession of the fact, to be recorded for the benefit of future painters in fresco.

If either of the suggested expedients was likely to answer, it seemed to me that the use of starch would present fewest difficulties of manipulation; I accordingly tried it first, and with so successful a result that I have thought it useless to attempt the employment of *caseine*; but I may mention that since my suggestion respecting it was made, a Scottish gentlemen has discovered and obtained a patent for a process of calico printing by means of a vehicle prepared from caseine and quicklime, which probably might be employed in fresco painting for the purposes which I have attained by the use of a solution of starch. This vehicle is prepared by dissolving caseine in the liquid ammonia of commerce, and adding to the solution a certain proportion of quicklime, the mixture then being diluted with water to any required consistency; and the inventor of the process (who entered into communication with me partly in consequence of the suggestions I had made in the paper referred to) thinks if his vehicle were employed in fresco-painting and mixed with all the colours, it would not be necessary to prepare the intonaco day by day, and, provided some expedient were adopted to keep it in a damp state, that even large pictures might be executed without, or at most with very few, joinings in the plaster.

This, however, I have not tried; partly from want of time, but chiefly because the more simple vehicle of a weak solution of starch, if it would not answer the same purpose, at least accomplishes the more limited object I had in view so perfectly, as to leave little to desire.

The use of ultramarine in a nearly pure state, hitherto the *crux* of fresco painters, presents, when the pigment is combined with a weak solution of starch, no difficulty whatever. It may be applied with tolerable certainty of effect even when the intonaco has become, as it does at the end of a day, hard and partially crystallised at the surface.

These conditions, however, must be attended to. In the first place the solution must be so weak that when cold it shall scarcely assume the form of a jelly.

Secondly, it must be used on the day on which it is prepared. On the second day it undergoes some change (I do not know what), which has the effect of causing the colours mixed with it to dry in streaks or blotches. If the same tint, therefore, has to be used on consecutive days, it must be prepared before hand with water, and the vehicle added only to so much of the pigment as may be required for the day's work.

Thirdly, the effect of the vehicle in fixing the colours cannot be depended upon with certainty unless the pigments contain a small portion of lime. This may seem to be an obstacle to the employment of colours in a perfectly pure state, but in practice this is of little consequence: in the first place because such a pigment as ultramarine (with which I am chiefly now concerned) can scarcely, except in minor details, be used with good effect in a pure state; and secondly, because the quantity of lime sufficient to insure the combination on which the action of the vehicle depends, is so small as hardly to affect the purity of the tint to any appreciable extent; and besides, the trifling loss of depth occasioned by the admixture of white may be easily corrected by the addition of black, which, though it imparts a certain greyness to the tint when it is wet, does not affect its blueness when the plaster is dry.

In preparing a tint of ultramarine in which the pigment is to be used in as pure a state as may be, I first make up the required tint with the least possible quantity of water; it is then diluted with the solution of starch to the proper consistency, and a small portion of lime added to it. The addition of the lime has the immediate effect of curdling or imperfectly solidifying the mixture. To remove this it must be triturated in a mortar, worked with the palette-knife on a slab, or, which generally is sufficient, stirred for some time with a stiff brush until the consistency of cream is attained. If the proper degree of fluidity should not be restored, a little water may be added.

It is, of course, desirable that the adherence of pigments with which starch has been mixed should in all cases depend on the chemical combination of the starch and lime; but it is certain that to a limited extent the glutinous quality of starch is sufficient of itself to secure the adherence of the colour under circumstances in which little or no chemical action can take place. As for instance, at the end of a day when the intonaco has become quite hard on the surface, I have found small touches and washes of pure colour (such as ultramarine or the transparent oxide of chromium unmixed with white) to adhere perfectly if applied with the solution of starch, which if applied with the water only would have dried on the surface of the intonaco in the form of powder.

On the durability of the process it is premature to express any opinion, as my experience only extends over three or four years; but as yet I am unable to trace in those portions of the frescoes in the Queen's Robing-room painted by means of it, the least symptom of that whitened, bleached, and inharmonious look which makes its appearance in blues, painted in the old way, almost before the paint has become dry.*

*The Oaks, Norwood, November* 21, 1853. W. Dyce.

* Accompanying the above paper in the Commissioners' Report is another, bearing upon the same subject, "On Silica, and some of its Applications to the Arts," by Rev. J. Barlow, M.A. This paper will be found at p. 382 of our present Number.

## OPENING OF ST. GEORGE'S-HALL, LIVERPOOL.*

This majestic structure, which may fearlessly challenge comparison with the old glory of the classic temples of Greece or Rome, was inaugurated on the 18th ult. with a ceremony befitting the interest of the occasion. While we regret the absence of royalty, as unfortunate in its immediate effects on the proceedings, we congratulate the town on the fact that the great hall has in itself elements which will make its inauguration more memorable than if it relied only on the more transient advantages of her Majesty's presence. To the young architect, Mr. Elmes, whose delicate constitution broke down under the gigantic undertaking to which he had given birth; to Mr. Cockerell, his adviser and friend, who has since that event directed and superintended the construction of the building, preparing designs when they were required, and perfecting in some instances the crude plans of Mr. Elmes; and to the St. George's-hall committee, with Mr. J. B. Lloyd as the most zealous and untiring member of it, the inhabitants of Liverpool are indebted for the erection and construction of this magnificent edifice, which, in the face of difficulties that would have been insurmountable by men of ordinary capacity, has been erected and well-nigh finished in the unexampled short space of fourteen years. There is, we believe, no other instance on record in which a building of such magnificent proportions, of such external boldness of execution, and internal elaborate profusion of ornament, has progressed with so much rapidity. It is, however, greatly to be regretted, that Mr. Elmes did not live to witness this triumph of his genius. One great mistake, in particular, would have been avoided. He would never have permitted the erection of an organ at the end of the large hall, blocking up the entrance to the Nisi Prius court, and thus deplorably interfering with the grandeur of the effect which would have been produced by the whole length of the building being open to the glance. The mistake, however, has now been made, and there seems to be little chance of rectifying it.

Another inconvenience which would have been prevented, had it pleased Providence to spare the life of Mr. Elmes, is the claim by another artist to the design of St. George's-hall. During Mr. Elmes' practice in London, he tenanted chambers with Mr. Bardwell, of Queen-street, Westminster, who, for the last four or years, has persisted in alleging that Mr. Elmes stole from him the entire design, with the exception of the present roof, which he substituted for a dome. This assertion has been renewed by Mr. Bardwell within the last few days, in a letter to Mr. Joseph Boult, in which he states that, before St. George's-hall was contemplated, he sent in designs for the Fitzwilliam Museum, at Cambridge; that the committee of taste having called in Mr. Cockerell, that gentlemen gave the preference to a design by Mr. Basevi; that this design was, therefore, accepted, and that Mr. Bardwell's was sent home; that Mr. Elmes saw and admired it; and that, in point of fact, he copied it, with the exception of the dome, which he replaced by the present roof. It will be remembered that Mr. Bardwell sent his model to the Great Exhibition of 1851, and affixed to it these words:—"Parent of St. George's-hall, Liverpool;" and it is said that Mr. Earle wrote for an explanation; that he got it, but never made it public; and that, in consequence, Mr. Bardwell has appealed at this telling time to the architects of Liverpool.

We are informed that Mr. Boult, one of the secretaries of the Liverpool Architectural Society, knowing that Mr. Rawlinson, the civil engineer, enjoyed Mr. Elmes' intimacy, sent him a copy of Mr. Bardwell's letter, and that Mr. Rawlinson in reply expressed his conviction that Mr. Bardwell's claim was not well founded, and that he did not believe he was entitled to the honour he coveted. The correspondence is in the hands of Mr. Boult, and will no doubt form the subject of some discussion, either before the Architectural Society or in the public prints. It has been suggested, we believe, that Mr. Bardwell should bring his model to Liverpool, and exhibit it at a meeting of the Architectural Society. Our own impression, backed by that of professional gentlemen of experience, is, that there may be some similarity between the designs, but that it is entirely accidental. The matter is certainly deserving of the closest inquiry, an inquiry, however, in which some attention should be made to the lamented fact, that the accused is not here to defend himself. It is somewhat strange that Mr. Bardwell permitted his injuries, for injuries he had if his statement be true, to lie dormant until after Mr. Elmes' death.

As a mass of building, St. George's-hall is, perhaps, the finest specimen of architecture produced in modern times. It is constructed by a legitimate application of the principles of the Corinthian order, having a fine dipteral or double portico of eight columns in front and four within, at the south end; a grand colonnade on the east side, which is pseudo-dipteral or with the depth of two columniations, but with only one rank of columns; and a circular portico of eight columns at the north end. These last are attached to piers; and the west front, or back, as some persons might call it, is columnar in character; these columns, like the semi-columns or antæ on the opposite side, being square. The whole building is a parallelogram more than 300 feet long, with lateral projections on each side of the central portion, which is occupied by what is strictly to be called St. George's-hall, while the north and south ends comprise respectively the civil and crown courts. But before we take our readers inside we must dwell a little on the exterior. The portico at the south end rises from a platform or base of sixteen steps, which have been doubled in depth, by reduction in number to one-half at the corners, to give a massive appearance, more in accordance with the great size of the columns, than the more convenient steps for ascent in the centre and at the sides. The pediment is filled with an elaborate composition of figures intended to represent Great Britain or Britannia, attended by Liverpool and the River Mersey, receiving the tribute of the world, through the intervention of Commerce, Science, and Art. This *groupe* was designed by Mr. Cockerell.

Unfortunately, Mr. Elmes did not leave detailed drawings, and it is difficult to understand, amongst other things, how he would have proposed to get over the inequalities of the site, being on the slope of a hill. For instance, the steps of the south portico terminate on a terrace, at a considerable height above the street; and a temporary, for we hope it is only a temporary means of access, has been provided by two obscure flights of narrow steps, cut to the right and left, out of the substance of the terrace or lower platform, the entrance to which is closed by elaborate bronzed iron railing and gateway, with two polished red granite gateposts of very peculiar shape. The east colonnade, or portico, is raised by nine or ten steps above the lower platform, which is again raised by a similar number of steps above the base-court. This platform, or terrace, extends round the south-end and the east side of the central portion of the building, and Mr. Cockerell has placed two pedestals on each side of the south portico, on a line with the columns of the east side, "to complete the geometrical form of the building," and he has surrounded the south end by a commonplace balustrade, of the shape almost universally adopted. One of the angles of this terrace is formed by a massive red granite pedestal, but unpolished, and on which the architect has suggested a piece of sculpture may be placed. The east side of the north and south portions of the building is formed by square columns, closed about one-third of their height up by a panelled wall, affording spaces for statues on the top between the columns; and square blocks on the face to be carved into artistic decoration. The depth of the portico on this side has been partly obtained by recessing it into the body of the edifice. There are three doorways in it, corresponding with three entrances into the great hall, and communicating by means of the corridor, which extends nearly the whole length of the building, to the Courts of Law. There is no pediment to this portico, which would, perhaps, be more strictly termed a colonnade, but it is only surmounted by the architrave and entablature which extend round the structure. Above this main mass there rises a small attic story, and within that again another larger attic story, if we can be justified in calling both these portions by that name.

The exterior, taken as a whole, is Grecian Anglicised—that is, the Grecian type is to some extent adapted to the exigencies of this climate, and the requirements of the present age. In the eastern and southern fronts the treatment is more severely classical than in the northern and western; windows are almost entirely excluded, the rooms on that side (chiefly used as ante-rooms) being lighted from above; the only exceptions are two four-light windows in the east portico, but these are so treated that they entirely harmonise with the prevailing sentiment. We are aware that the isolated antis, or square columns, are exceptional with rigid classicalists, but their use in this instance seems justified by their position in the line of a wall, and by the contrast they present to the fluted circular columns of the porticoes.

* A description, with engravings of the St. George's Hall, will be found in the Journal for 1843, Vol. VI. p. 330. The descriptive particulars in our present Number we have abridged from the 'Liverpool Albion,' and the 'Liverpool Mercury.'

In the other parts windows are freely introduced wherever they are requisite; so that there is an agreeable variety in the composition of the whole, no two views of the building being similar. Mr. Huggins has made some excellent remarks upon the increased effect that this edifice will gain by the liberal introduction of sculpture: his suggestions will be found at the end of the present paper.

If we turn to precedent, we find that the Greeks represented their Public Games and Incidents combined with manners and customs which were familiar to the whole people; the myths of all their deities were "familiar as household words," and required no handbooks for their explanation. With us they are *caviare* to to the multitude: it is the scholar only by whom they are really appreciated. Is, then, the pleasure of many to bend to a few? And is the revival of the arts to be still further delayed by continually disgusting the public at large with unpolite reminders of their want of classical cultivation? There is some hope that other tastes will in time prevail, and that when the plaster casts in the north vestibule have fulfilled their temporary purpose, they will be supplied by bassi relievi, in which English people generally can feel interested, and comprehend without the aid of an interpreter. Mr. Cockerell's taste is so scholarly and classical that he is apt to overlook the distance that separates him from the general public, and, perhaps, rather to contemn the feeling that would cater to their unclassical culture. But he does his own ability great injustice when he so restricts the circle of his admirers, and also deprives many of that refined enjoyment he is so well qualified to give. It is not likely that commercial men will feel complimented by the frequent introduction of Mercury and his emblems, when they learn that he was the patron of thieves as well as of merchants, which seems to imply that one sort of men is just as good as another. The lictor's rod, when shorn of its authoritative axe, seems likely to remind the profane vulgar of a chimney-sweeper's machine, and to excite amusement rather than respect. And even cultivated Englishmen, unless ultra-scholars, may rebel against the monogram "S.P.Q.L.," inasmuch as they may think modern Liverpool, though not an empire city, is in many respects superior to ancient Rome; and that, as the British empire lives in active energy, she should impress her distinctive character on the monuments she bequeaths to history.

### *Description of the Interior.*

On entering the building through the principal entrance in the east portico, and turning to the right along the eastern corridor, the three rooms on the right hand are for witnesses, and adjoining them on the north is a retiring room for the jury; then the vestibule of the north entrance, in which is a descent of several steps, giving access from three doors on the level of the street, on the right and left of which are cloak-rooms, under the floor of the upper vestibule. This vestibule is in the shape or plan called horse-shoe; that is, it consists of a large semicircle with the addition of a small parallelogram, the semicircle being outwards; round the interior of the semicircle is a gallery on the level of the upper floor of the vestibule, the rest of the area being occupied by the steps and "crush-room." The vestibule is finished in an extremely simple manner, the order introduced is Doric, freely treated, the wall spaces between the pilasters decorated with casts of bassi-relievi after the Elgin marbles. From this vestibule are two staircases giving access to the small concert-room, which is small in comparison with the great hall, but is calculated to accommodate an audience of 1200 or 1500 persons. This room is over the vestibule and of the same shape, the orchestra being placed on the straight side. The room is to be fitted up with seats on the floor and in boxes, but is unfinished.

Returning to the principal floor, and entering the western corridor, the first room on the right hand, after leaving the north vestibule, is the under-sheriff's room, then the prothonotary's office, a retiring-room for solicitors, a room for the clerks of barristers and solicitors, a retiring-room for the jury, the court of the vice-chancellor of the Duchy of Lancaster, 29 ft. 6 in. by 23 ft., with a retiring-room; a robing-room for barristers; the library, 41 ft. by 23 ft., a second robing-room for barristers; the sheriff's court, 29 ft. 6 in. by 23 ft., with retiring-room; a retiring-room for the jury, the crown-office, office for the clerks of the crown and peace—a room for arbitrations bringing us to the south-west angle of the building. Then proceeding through a handsome staircase, we enter the south vestibule, having access through one large door into the south portico. Passing through the vestibule we enter another staircase, in which is the muniment-room, entered through a retiring-room; and again entering the eastern corridor, we find three witness-rooms, corresponding with those at the north end of the same corridor. The centre of the building is occupied by the great hall, with the civil court to the north, and the crown court to the south, each court being provided with the usual retiring-room for the presiding judge. The courts and hall are of course entered from the corridors, as also the judges' retiring-rooms. If now we return to the staircase in the south-east corner, and ascend to the upper floor, we find the retiring-room for the grand jury at the top of the stairs, and the grand jury-room over the south vestibule. Passing through this room we come to the staircase in the south-west angle, out of which is a waiting-room for witnesses in attendance upon the grand jury, and then, proceeding along the western corridor, we have on the left hand a store-room, the high-sheriff's room, committee-room, or room for arbitrations, the office for the clerk of prosecutions at sessions; and at the north end of this corridor four retiring-rooms in connection with the smaller concert-room, the centre portion of this corridor forming the western gallery of the hall. In the basement on the west side of the building, beginning at the south end, are two rooms for gaolers, and four rooms for the housekeeper. Then the culinary department, including butler's pantry, larder, wine cellar, and extensive accommodation for cooking, furnished with two large hoists to raise the dinner to the western corridor for conveyance into the hall. At the north end of the basement are six rooms for the keeper of the court. Near each end of the basement is a hydrant immediately connected with the main from the reservoir.

In the sub-basement are thirteen cells for prisoners awaiting trial, one of which is appropriated to the gas-meter of the great hall; a kitchen for the turnkeys, lumber-rooms, and cellars for fuel, &c. Without the building, at this level, is a carriage porch, with gates at each end. During the assizes the prisoners for trial are brought in the van each morning from Kirkdale, and entering this porch at the south end, the gates are secured before the door of the van is unbarred. The prisoners are then disposed in their several cells, which are fitted up with every requisite, including a bell to which a signal-plate is attached. Should a prisoner require attention, he pulls his bell, and the signal-plate flies out from the wall, and enables the attendant to see at once in which cell he is required. In connection with the dock, in the court, is a staircase communicating with the basement of the building, by which the prisoners are led in as their cases are called on; and in order to prevent loss of time by having to fetch each prisoner from his cell, as required, there is a waiting-room attached to these stairs, where those immediately in succession to the one in court are kept in readiness.

The whole of the basement and sub-basement to the east of the western corridor, with the exception of stairs to the docks and the waiting-rooms for prisoners, is appropriated to Dr. Reid, whose ventilating and warming apparatus, with furnaces and steam-engine, occupy a great part of the basement, where there is also another steam-engine to blow the organ.

### *The Hall.*

Returning to the east entrance, it is to be regretted that this, the principal approach to the interior of an edifice of such importance, should be so meagre internally. The utter absence of any vestibule forms a marked contrast with the two secondary entrances at the north and south ends, which, especially the former, are as spacious and imposing internally, as the sudden admission into the east corridor from the central entrance is the reverse. Such an arrangement necessarily impresses the observer that the ground is too confined in depth for the edifice which is placed upon it; and he cannot but regret that the area in front was not a little more contracted, as the abstraction of the space requisite for a handsome vestibule would scarcely be observable in so large a piece of ground, besides that additional comfort would have been given by the vestibule to the hall. From the central portico admission is gained by three doors into the corridor, and thence by three other doors *vis-a-vis* into the hall, which is entered upon a platform, surrounding the interior of the magnificent apartment, at a level of 18 inches above its true floor. This difference of level appears to be made for the purposes of ventilation, as the riser of the platform is formed of cast-iron diagonal tracery. The length of the hall is 169 feet, from north to south, including the recesses at each end, the width 74 feet, exclusive of the galleries, which are constructed over the east and west corridors, and 13 feet in depth, making the total width at this level 100 feet. On each side of the hall are six columns of polished porphyry from Peterhead, dividing the length into five compartments; from the entablature on these columns springs the vaulted ceiling, which is in one span, from column to column, across the hall. The galleries are divided into *quasi* boxes by massive piers built behind each column to form the abutment of the vault, which is constructed of hollow bricks, at the suggestion of Mr. Rawlinson, C.E., of London. The great vault is intersected on each side by lateral arches, springing from pillar to pillar across the front of the galleries, giving more loftiness to the design,, and concentrating the thrust of the arch upon the columns and their massive abutments. Both the main vault and lateral arches are semicircles in section.

The arched ceiling, 84 feet above the ground, is formed of plaster upon the brick vaulting. Above the crown of the lateral arches the ceiling of the main vault is divided into three great divisions in the circumference of the arch, and into five great divisions in its length; thus forming fifteen primary compartments in the whole ceiling. Each of these is again subdivided according to a general design, which consists of a small square panel, containing a golden star in each angle of the primary divisions. Between these four small panels are oblong ornamented panels. The upper horizontal panel is filled with mouldings intersecting diagonally; the ground of the lozenge so formed is the brick vault, the perforations of the hollow bricks relieving the heaviness of the flat surface. The lower horizontal panel contains mermaids carrying lyres or blowing conch shells, on either side of a mask or the head of a trident. The two vertical panels contain the caduceus or a lictor's rod, both terminated in enriched finials. The centre of each primary compartment is filled with a coat of arms or the device of St. George and the Dragon: in the central compartment are the royal arms, flanked east and west by the arms of the county of Lancaster; north and south of the royal arms are the county arms, flanked by the arms of the borough of Liverpool; and north and south of the county arms are the borough arms, flanked by St. George and Dragon. The mouldings of the panels are enriched in various ways, chiefly with the guilloche and egg-and-dart. The effect of the ceiling above the crown of the lateral arches is extremely pleasing, that effect being greatly augmented by the judicious yet sparing introduction of colour (light cobalt blue) as the ground of the panel, and gilding and colouring in the arms and devices.

At the intersections of the lateral arches are the prows of vessels, on the antique model, from which are suspended the gas pendants for lighting the hall; and the spandrels of these arches are filled with allegorical female figures of colossal size, said to represent the Virtues. Below these is the entablature of the polished porphyry columns, the caps of which are of plaster; painted in imitation of the porphyry; the curvilinear frieze of the entablature is also painted porphyry, which seems rather erroneous, since it subjects the painter to an unequal competition with nature, or throws suspicion upon the genuineness of the natural production. The columns stand upon a dado of red and blue granite, all polished, and continued round the hall, the combination of colours very agreeable. In the wall at the back of the boxes, on the west side, are large windows, rising nearly to the entablature; above the entablature the semicircular space included within the arch is divided into compartments, containing in the centre arch the arms of Liverpool, modelled in plaster; in the arch north and south of this is the device of St. George and the Dragon; and north and south of these the county arms, and under each coat of arms or device is the monogram "S.P.Q.L." ["Senatus Populus Que Liverpooliensis"] in a wreath of oak leaves. The arched recesses on the east side are similar except that there are no windows, the plaster on the wall being divided into horizontal rustications.

Between the piers built behind the columns is a balustrade in front of the gallery, which is constructed of square dies of green marble, with moulded balusters of alabaster, or Derbyshire spar, and a hand-rail of black marble. Below this balustrade the wall space is occupied, in three compartments on each side, by handsome brass doors of elaborate design, with a niche on either side of each. On the south of the central west door is Noble's fine statue of Sir Robert Peel. The figure is erect in the attitude of speech, dressed in the well-known frock coat, relieved by the drapery of a cloak. In the other two compartments, on each side, the wall space is divided into three niches, one square and two semicircular; the backs of the square niches are formed of green marble. In the southern square niche on the west side is Gibson's statue of George Stephenson, who is represented sitting, and the likeness is more correct than in Baily's statue at Euston-square. These statues show how much such accessories will add to the splendour and interest of the hall.

Every available spot within the hall has been painted or filled with coloured material. Much remains yet to be done, and it will be difficult to form an opinion of the general effect until it is more nearly completed, and the scaffolding and other working appliances removed. The width of the hall is about 75 feet. The five windows on the west side are 18 feet high, and 8 feet 6 inches in width, and there are two semicircular windows at the ends, 33 by 17 feet. It is contemplated to fill these with stained glass, and designs were sent in by various parties. The first prize was awarded to Mr. Miller, of London; and the second to Messrs. Pilkington, of St. Helens. The latter gentlemen applied to Mr. Frank Howard for designs, and he proposed to fill one semicircle with an illustration of the Law, and the other with an illustration of the Arts; the window facing the central entrance with a St. George and the Dragon, occupying the whole space; Commerce and Industry in the side windows; and in the intermediate windows an ornamental design, admitting medallions of Mr. Elmes, the architect, Roscoe, Canning, Huskisson, and other distinguished men connected with the town. What will be done is not yet determined; but temporary glazing of sufficiently hideous character has been adopted.

At each end of the hall is a semicircular-headed recess, square on plan, and the width of the great vault: that at the south is finished with columns of porphyry, similar to those which carry the lateral arches, and a screen of smaller columns of grey granite, and handsome brass tracery, similar to the doors; this screen divides the hall from the crown court. The recess at the north end was to have been finished in the same way, but as no place had been provided for the organ, it is here erected, and the two porphyry colums have been removed to the exterior of the building, and are erected opposite the railway station—their alleged purpose being to carry lamps.

### *The Floor.*

The floor is composed of encaustic tiles, manufactured by Messrs. Minton, Hollins, and Co., of Stoke-upon-Trent, and is the largest pavement of the kind in existence. The design is very elaborate, but has been very successfully carried out, although it presented great difficulties of a technical character. It is difficult to give a correct idea of the design by a comparison with any other, ancient or modern; and although there are many fine examples of tile paving in the churches and palaces on the continent, and in some of our own cathedrals and conventual churches, yet they cannot be quoted for the purpose of conveying a true idea of the pavement in St. George's Hall, whether as regards its great size, the arrangement of the design, or, especially, as regards its colouring.

The antique practice of tile making, as appears from the existing remains of ancient works, confined the manufacturer to the use of few colours or tints. The method commonly used seems to have been this:—A piece of well-tempered clay having been prepared of a proper size (usually about 6 inches square, and 1 inch in thickness), a die, having some ornament in relievo, was pressed upon it; the indented pattern thus produced was then filled in with clay of some other colour, generally white; the tile was then covered with a metallic glaze, which imparted to the ground (usually red) a deeper and richer colour, and gave the white ornament a yellowish hue. These tiles were often arranged in sets of 4, 16, or more, and were intersected with bands of plain tiles, of a self-colour, such as black, red, and white, and frequently displayed great geometrical skill and beauty of effect. Good examples may be seen in the churches of St. Denis and St. Omer, in France, and specimens from the abbeys of Juvaulx, Westminster, and other buildings in England. The modern process of encaustic tile making, as adopted by Messrs. Minton, Hollins, and Co., enables them to produce not only a far greater variety and brilliancy of colour in the general effect of a pavement, but admits of several colours being placed upon a single tile, thus producing the soft effect of fine mosaic work, in a much more durable and less expensive material.

The extreme length of the floor is 140 feet, the breadth 72 feet, containing upwards of 30,000 tiles. The general form of the design may be described as consisting of three large circles, the largest being in the centre, and two smaller ones, one on either side of the great circle, towards the end of the hall.

These two smaller circles are each surrounded by four still smaller, the form being then terminated at each end by a semicircle, of a radius equal to that of the great circle in the middle of the design.

In the centre of the pavement are introduced the royal arms, in proper colours, on a deep blue ground, 5 feet in diameter, surrounded by a wreath of laurel, and mounted on a star of 16 points, the spaces between the points being filled up with rich ornament and the caduceus of Mercury, thus forming an elaborate centre piece, of 15 feet diameter. This is enclosed by a narrow border of stone, and then follow rich bands of classical ornament, and a frieze of "life-bearing ornament," composed of tritons, sea-nymphs, dolphins, genii, tridents, and other attributes of Neptune, displaying great merit in design and successful execution. This is again bordered by richly ornamented bands to the outside of the great circle, making a diameter of about 42 feet.

In the centre of the two smaller circles are the arms of the corporation of Liverpool, also in proper colours on a blue ground, 3 feet in diameter, and surrounded in like manner to the great central compartment by consecutive rings and bands of ornament.

In the other small circles are introduced the Star of St. George, the Rose, Thistle, and Shamrock, with suitable borders which intersect at the junction of the circles with each other, after the manner of the Roman guilloche, or chain ornament, thus bringing the whole together into one grand form.

The semicircles at the ends are treated in the same style of ornamentation as the great central circle, and are incorporated, by the interlacing bands, with the central forms of the design.

The rest of the floor is filled in with a rich diaper work, divided into panels of various sizes by diagonal bands of plain chocolate-coloured tiles, having an ornamented tile at each intersection. In each of the largest of these divisions are placed alternately the Rose, Thistle, and Shamrock. The floor to the extent of about seven feet from the walls is raised about 18 inches from the central part, forming a sort of platform or pathway all round the hall. This is also laid with tiles of a similar character to the other parts of the pavement; and opposite each of the side doors is a circular compartment of rich colour, having in the centre a dolphin in proper colours on a deep blue ground, with wave-scroll ornament, &c. The spaces between them are filled with diaper work, with appropriate borders. The space immediately under the organ gallery is laid with a beautiful panel of about 20 feet diameter, having in the centre the crest of H.R.H. the Prince of Wales, within a laurel wreath, and surrounded by bands of richly decorated tiles.

In the border which surrounds the diaper work on the platform, and opposite each of the polished granite columns, are inserted inscriptions and mottos in Latin and English, relative to those virtues, sciences, and arts typified by the figures in the spandrels of the arches above—the lateral arches of the hall. At each end of the hall, also, inscriptions are introduced. Those near the organ relate to music; and those at the oposite end, leading to the entrance to the court, are relative to justice and government.

On entering the hall by the south entrance, and descending the steps, we read on the right hand—

"A king shall rule in righteousness, and princes shall rule in judgment."

And

"Libertatis honos et sceptra jura decori."

Proceeding onwards, opposite the figure of Prudence, we read—

"Nullum numen abest si sit Prudentia."
"I, Wisdom, dwell with Prudence."

Next opposite the figure of Fortitude is placed—

"Tu ne cedi malis sed contra audentior ito."
"In the Lord I have righteousness and strength."

Then underneath the figure of Science we have—

"Felix qui potuit rerum cognoscere causas."
"The fear of the Lord is the beginning of knowledge."

Next comes Art, beneath which is inscribed—

"Ars operum inventrix naturæ que æmula prolis"
"He hath given me skill that he might be honoured."

Then Justice, opposite which we have—

"Discit justitiam moniti et non temere divos."
"By me kings reign and princes decree justice."

Next Temperance, when we have—

"Ne quid nimis."

And we are admonished to—

"Add to knowledge temperance."

Then proceeding round towards the organ gallery we read—

"Praise Him with stringed instruments and organs."

And

"Fortia facta monet curarum et dulci levamen."

The mottos on the other side of the hall being the same, but in reversed order, according to the figures above them; and at each corner of the floor appears the motto of the corporation—

"Deus nobis hæc otia fecit."

It is said that the cost of the floor is 2000*l.*, but the precise amount is uncertain. It is, however, asserted on good authority that the sum, whatever it is, is considerably below the cost to the manufacturers, and that this is mainly attributable to the liberality of Mr. Minton, who, in a worthy spirit, on undertaking the work, determined to spare no amount of labour and expense to render the pavement as perfect as possible, and in every respect worthy of the noble hall of which it forms an important decoration.

### *The Brass Doors.*

At the three entrances on the east and west sides of the hall are six pairs of massive brass doors and frames of very elaborate design. They are fixed to marble jambs, and have a rich and imposing effect. Each pair of doors, including the frames, measures 12 ft. 8 in. high by 6 ft. 4 in. wide. The frames are very bold, of a receding outline, with a rich leafage moulding, which terminates against the marble jambs; in the hollow or recess of the frames is a large egg-and-dart ovolo, running all round. The doors are hung to the frames with strong gun-metal hinges with steel centres; they are 2½ inches thick, but not of solid brass; they have a hollow core with a covering of sheet brass of a thickness of 8 lb. to the superficial foot. The core is composed of 1½-inch square metal, put together in a form to prevent racking; each door has a circular panel in the centre brought out by an enriched bead and other mouldings, with a receding disc, having a head of Mercury in the centre. The foliated panels are of very rich design, and appear to run through the disc, starting at the base with two dolphins, the tails entwined, supporting a trident which runs up the whole length of the panel, with foliated scrolls intersecting it throughout, and in which is a small band with the monogram "S.P.Q.L." The doors are panelled with enriched mouldings on one side, and studded with rosettes on the other or outside; also panelled with a plain bold moulding to receive plate glass. One valve of the door is fastened by a rack bolt shooting top and bottom, the other by a two-bolt lock.

Over each door is a square light, constructed in the same manner as the doors, but the foliage is different. In the centre is the liver, the crest of the town of Liverpool, running round which is a bold wreath of oak leaves, and from the wreaths on each side springs a bold scroll, terminated with the honeysuckle. Each pair of doors, including the frame, weighs 43 cwt.

The screen at the south end of the hall, and dividing it from the crown court, is of similar design and construction. It is 21 feet long and 12 feet high, and weighs 74 cwt. This screen has one pair of folding and two single doors, on the same principle as those at the sides of the hall.

The total cost of these doors is about 6000*l.* They were made by Mr. Potter, of South Moulton-street, London, from the design and under the superintendence of Mr. Cockerell.

There is a smaller screen in brass to be fixed under the organ gallery, 10 feet wide and 8 feet high, in four compartments of the same construction.

At the south entrance of the building will be a large and massive pair of bronze doors, 21 feet high and 11 feet wide: they are of rich design, and weigh about 7 tons. Each leaf weighs in itself about 2½ tons, and works very freely; but as the labour of opening and shutting these doors frequently would be very great, there will be a wicket in one of them.

These are the largest metal doors in England.

### *The Gas Pendants.*

These splendid decorations are in brass and bronze, and each weighs about a ton. Yet, massive as they are, they look light, graceful, and elegant—a result due to the felicity of the design, the harmony of the parts, and the delicacy of the work. They are Grecian in design; not purely so, but the spirit and feeling of the Greek forms have been preserved with no little tact and skill. Each pendant is about 17 feet in height, suspended by a cable-formed rod, with elegant bosses at intervals, 20 feet in length, so that the entire work is 37 feet high, with a diameter at the widest part of 8 or 9 feet. From a small canopy descend two rows of cables, wrought in brass. The outer row upholds a large corona, and the upper row a smaller corona beneath, from which again depends an elegantly shaped basket, terminating at the bottom in a richly decorated pendant, and knob, or globe. On the upper rim of the canopy is placed alternately a five-pointed star and the liver. Each point of the star emits a brilliant jet of gas. Beneath the birds and stars is a border formed of the acanthus placed alternately with rams' heads; and beneath these runs a border of the echinus. To the inner portion of the latter are attached the chains which support the rings or coronæ below. The larger corona, fixed in the middle of the pendant, is decorated by the prows of ancient galleys, each armed with a projecting spike issuing from a boar's mouth, and alternately with boldly carved masks, the execution of which is very good. Above each prow rises a large star, five-pointed like those on the canopy, and also emitting a jet of flame from each point. On the lower and smaller corona the liver re-appears, and the masks and stars are again introduced. The basket (the sides of which are perforated with the Greek anthemion) recedes in graceful lines, till at the lowest part it narrows into a stem clasped by acanthus leaves, below which are a series of tasteful mouldings, ending in the final globe. There are ten pendants, and each bears 140 lights. The design is at once appropriate and novel. It does not, as is too often the case, block out all beyond; but, on the contrary, will serve to heighten the effect of the architectural ornamentation with which it will be placed in juxtaposition, inasmuch as, from its peculiar character, every detail may be seen through the interstices of the pendant. The delicately pale bronze and the rich gilding which alternate have a very fine effect. The rapidity of the production of these pendants is very remarkable; three months have not elapsed since the order for these, and a multitude of smaller chandeliers, brackets, &c., was given. The workmanship of the pendants is admirably finished, and reflects great credit upon the manufacturers, Messrs. Messenger and Son, of Birmingham. The illuminating effect is very brilliant; the great height at which the lights are fixed protecting the audience from all offensive glare, and securing that agreeably soft light which is so admired.

### *The Organ.*

It was the intention of Mr. Elmes to produce a vista from court to court through the hall, the entire length of the three apartments being nearly 300 feet. It is much to be regretted that the important provision in a music hall, of the organ and orchestra, was overlooked, as, placed as they now are, they have necessarily an intrusive appearance, and seriously interfere with the effect of the hall and with the available space.

This gigantic instrument is the joint production of Dr. S. S. Wesley and Mr. H. Willis. The case has been constructed from the designs of Mr. Cockerell. Its entire cost will probably be between 8000*l*. and 9000*l*. The choir and solo organ is not yet completed; but it is expected that the whole instrument will be perfectly finished in six weeks or two months. In consequence of the delay in the progress of the building, and the difficulty of getting all the works completed by this period, the voicing of the instrument has been done under very great disadvantages.

The instrument consists of four rows of keys, from G to A, *i. e.*, GG to A in altissimo, 63 notes; and two octaves and half of pedals, from C to F, *i. e.*, CCC to F, 30 notes. There are 108 stops, and 8000 pipes, varying in length from 32 feet to ⅜-inch, ten octaves apart.

The bellows of this great instrument are worked by two steam-engines, which furnish an aggregate power of ten horses, and were constructed by Messrs. Fawcett and Preston. The largest pipe has an area equal to 2 ft. 8 in. by 2 ft. 5 in., whilst the smallest is less than ⅛-inch in diameter. The notes are ten octaves apart.

The grand source of the wind is from two immense bellows, each having three feeders, placed in the vaults below the hall. These are blown by a steam-engine, consisting of a pair of oscillating cylinders. There are, besides, twelve other bellows, or reservoirs, each giving its own appropriate pressure of air to those stops or pipes which it supplies.

The pneumatic lever is applied to each of the manuals distinctly, and also distinctly or separately to the manual couplers. To the pedal organ there is a double set of pneumatic levers; but the most elaborate use of this power is found in its application to the combination of stops. Here we have it exhibited in a compound form to each organ individually, and to the whole collectively, where, by one operation, the player is enabled to produce a combination of stops upon the entire instrument at once. This movement appears in a series of six handsome gilt knobs, placed immediately under each set of manuals, at about two keys' distance from each other, occupying a central position, and always within reach of one or other of the performer's thumbs. The pneumatic lever is also applied to the opening and shutting of the swell louvres and some other important purposes. The very extensive use Mr. Willis has made of this extraordinary power seems to have rendered any deviation from the ordinary valves, in immediate connection with the pipes, unnecessary, excepting in the pedal organ, where the large pipes have a very peculiar valve for their supply, which is quiet, sound, and free from the resistance resulting from the compressed air.

### *Crown Court.*

To the south of the great hall is the crown court, which is rectangular on plan, 50 feet by 47 feet, with a recess or niche, with semicircular head, of 32 ft. 6 in. by 6 feet, in which the bench sits. The general arrangement of this court resembles the hall, inasmuch as there is one main vault, supported by three lateral arches, which spring from four columns of polished porphyry. Between the cap of the columns and the spring of the arch an entablature is interposed, which is returned on the sides of each column, and is supported at the wall end by pilasters, also of polished porphyry. The ceiling is panelled. The light is admitted through the centre of the principal vault by curvilinear windows, the glazing of which is only temporary. The ceiling is painted stone colour, with the mouldings relieved in white, and has a very agreeable effect. The fittings are of oak, and the walls to a considerable height are painted in imitation of oak-beaded match boarding. The court is divided from the hall by the columns and screen before described.

### *Nisi Prius Court.*

At the north end of the hall is the civil court, which is also rectangular, 50 feet by 46 ft. 6 in., with a niche for the bench 32 ft. 6 in. by 5 ft. 6 in. The arrangement of this court is different from the other, and it appears to be somewhat larger, though actually of rather smaller dimensions. The basilica type is adhered to, but the lateral columns of polished porphyry are nearer to the walls, and the entablature is continuous in the length of the court, there being no lateral arches. From the cornice rises the vault over the centre of the court, which is semicircular in section, with the upper segment of the semicircle retrenched; on the chord-line are flat windows for the admission of light, the glazing of which is also temporary. The ceiling of the side compartment, or aisles between the columns and the walls, is flat, but coffered. The niche for the bench resembles that in the crown court in being square on plan and finished with a semi-arch; but the columns, in both of grey granite, are differently disposed. These fittings are likewise of oak, but the ceiling and walls are not yet painted.

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The day which witnessed the close of the musical entertainments was distinguished by the opening of the campaign of science under the auspices of the British Association, who do Liverpool the honour of holding their twenty-fourth annual meeting there. This naturally carries us back in imagination to about the same time in the year 1837, when this learned body there held one of their important and eventful meetings, and at which Dr. Lardner read his memorable and ill-fated paper on steam navigation. On that occasion the Earl of Burleigh occupied the chair.

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Sir—The just celebrity of St. George's Hall, as an intellectual application of Greek architecture to a modern purpose, and, in most respects, one of the noblest buildings in the empire, must invest with more than ordinary interest for the people of Liverpool the masonic and other mechanical operations now going on around it. All will be anxious that the accessories and finishings of the exterior be in every respect worthy of, and suitable to, the main structure, between which and its external appendages a perfect harmony should reign; a harmony arising out of unity of conception, congruity and relation of the parts, each (whether architectural or sculptural) rendered completely subservient and *actively* beneficial to the effect of the principal subject, namely, the building.

To any one, however, acquainted with the commonest principles of art, the operations alluded to must, for a considerable time past, have worn a very suspicious aspect, and must have at length furnished ground for something more than fear that the resulting forms will not only fail in embellishing the building but be seriously detrimental to its character and beauty.

For what else, in the first place, can be said of the granite columns just raised in Lime-street? What purpose but that of destroying all unity can be answered by vertical objects so placed that, from every good point of view, they must cut up the principal façade into two or three sections? Had the building been a Gothic one, with pinnacled buttresses and a predominance of perpendicular lines, the case would have been different; but the characteristic charm of St. George's Hall is the binding up of its varied parts—its open courts and solid walls—into one harmonious mass, by the all-embracing and all-uniting horizontal lines, —and this is seriously affected, if not utterly destroyed, by these interfering and intersecting objects. What may be the actual intention of these columns it is unnecessary to inquire, for no form or finish they can now assume can either give them a right meaning and justification, or render them innoxious.

But this is not all. Than the edifice in question there is perhaps no building, except the Greek temple itself, that is more dependant on its columns and pilasters for its æsthetic qualities; indeed, the exterior may be said to be made up of columns, and its most striking beauty to consist of the graces of peristylar perspective. For the embellishment of its fore-ground, therefore, no form, used on such a scale, could possibly be worse adapted than the Corinthian column, as in the nature of things, it could not fail to dwarf the corresponding features in the building, and weaken the effect of columnar grandeur throughout.

But besides the form and loftiness of these pillars, their polish and superior richness of material and warmth of colour, must be not a little injurious; for such qualities will inevitably detract from the delicacy and beauty of the façades, and thus impoverish what they were designed to enrich, and diminish results they ought to heighten.

It will perhaps be answered, that erections similarly proportioned in the shape of obelisks were placed in front of Egyptian temples, where, it is allowed, all is harmony and consistency. This is true. But the Egyptian obelisk, though somewhat similar in proportion, was of a very different nature to the Greek column; and so far from dividing or otherwise injuring the mighty mass of the temple propylæum, must, on the contrary, by its slender, needle-like shape, have greatly enhanced the qualities which it (the temple front) was designed and intended to embody.

While the Lime-street columns, by their abacus and capital, declare their fragmentary and imperfect nature in themselves, and bear unmistakeable reference to an horizontal beam or lintel with which they should be weighted, the Egyptian obelisk is a pillar *per se*, based on an entirely different type, and suggesting like a plant, ideas of growth and aspiration. And, as if to make this idea more distinct, and prevent the possibility of its being mistaken for a ceiling or lintel-bearer, its designer pointed the top into a square pyramid. The sight of an Egyptian obelisk or Turkish minaret might make us blush for our monumental columns.

And this is not the only feature of the accessories of St. George's Hall that is injurious in its tendency. The entire surrounding balustrade is an appendage that no architect can look upon without distrust, the balusters being of far too elegant a form—too flowing and sensuous in line, and the whole balustrade too minute and complex in division, for harmony with the lineal severity and simplicity of the edifice, the extreme angularity of which it must render more apparent by its introduction near the eye, and on a level with the basement, where, above all, should be preserved an unbroken massiveness and simplicity.

Would not the expense that is thus worse than thrown away have procured the much-needed embellishments for the building itself? Would it not have crowned the front and principal portico with statues (one over each of the columns), or surmounted the pedestals at the extremities of its summit by figure groups? Whether or not, such embellishments of that portico is requisite, if only to balance the pediment sculpture at the south end, and give it its due decoration as the grand entrance, a distinction to which its superior breadth and columnar dignity, as well as its central position, unmistakeably points.

I hinted above at the impropriety of using the columnar form for any purpose but that of supporting an entablature. I did so under the impression that it is not too late to fear a Liverpool reproduction of the Trajan pillar, that conjunction of architecture and sculpture by which common-sense has been so often insulted —an arrangement of art-elements which degrades the columns to the rank of its own pedestal, and wherein, the principle of subordination being lost sight of, it can serve no other purpose than that of eclipsing the statue by its richness of capital, if it does not, by its aerial position, throw it out of sight altogether. Let us trust, however, that in this, as well as in some other particulars, we shall not see repeated in our St. George's-place the absurdities of Trafalgar-square.

In penning these remarks I have but slight hope of their effecting in any degree the remedy of the complained-of evils; and my apology for this intrusion on your space must chiefly be the fact that the credit of the architectural profession demands that some such protest be recorded.

SAMUEL HUGGINS.

*Liverpool, August* 21, 1854.

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SIR—At the conclusion of my former letter on this subject I suggested the embellishment, by statues, of the great central portico as a means of producing a right balance and consistency in the building, but did not urge, or with sufficient emphasis urge, its abstract claim as a condition of completeness. To do this I must again trespass briefly on your space.

The species of embellishment in question, the grandest conceivable one of architecture, would, I unhesitatingly maintain, have been due to the building, though not a particle of sculpture had been inserted in the south pediment. It is an addition imperatively demanded by its rank and style, lacking which the whole must fail of its legitimate and rightful effect, and fall short in general power over the mind of far inferior edifices, wherein the conception has been fully developed by phonetic sculpture; for the absence of which no array of elegant balustrade, or elaborate pallisading, or granite lamp-posts, will atone. Statues over the broad colonnade of the central portico, disposed as should be found best, and varied and relieved by groups at the extremities, while they would find an excellent background in the astylar wall of the receding crown of the building or attic, which would receive much-needed relief from them in return, would give life and soul to the centre, and through it to the entire body of the structure. For such embellishment would not be merely the addition of beautiful accessories, but, when treated in the true spirit of the architecture out of which it should appear to have grown as a thing of like essence, and each figure seem the genius of the architectural mass beneath it, it would be a transfusion of life and beauty through the whole, awaking it, as it were, to a new existence, and raising it to a higher and purer region of art.

It was for such adornment and vivification of architecture that statuary and figure sculpture had birth in ancient art. In Greece, whence the elemental origin of St. George's Hall, as well as in mediæval Europe, architecture and sculpture grew up together, and like body and spirit, could not, without death to the former, be separated; and in Egypt sculpture seems to have had no separate existence. It was exclusively the handmaid of temple and palace architecture, *i. e.*, of high architecture, in which, in all great periods of art, want of figure sculpture has been looked upon as want of full being or entity.

I am not of the opinion recently expressed by a popular writer on the subject, that sculpture is the entire essence of architecture. The latter I hold to be a great art in the possession of proportion and form, and I believe that a fabric of exquisite beauty might be produced without any contribution from the high class of sculpture in question. But in great monumental works of the rank claimed for St. George's Hall, a certain amount of statuary and other sculpture is an essential element, without which it cannot have full existence, but must remain so far immature and undeveloped.

Architectural skill has been directed to the bringing of the surrounding neighbourhood into keeping with so noble a centre, and giving the latter, by the erection of other handsome buildings in its vicinity, a few congenial and worthy associates. This is a very laudable and well-conceived object, and the plan laid down for it reflects credit on the young architect of "the proposed St. George's-place." But the "improvement" for which I contend has a prior and loftier claim, for there must be more propriety in first, by suitable sculptural adornment, hiding the nakedness of the building itself, and giving it the full garment of its beauty.

Nor need the expense of all this be any bar to its accomplishment. For the cost of architectural figures is, or may be rendered, very slight in comparison with that of independent attitudenising statues, by the broad and simple mode of treatment and absence of finish which the spirit of the architecture and their distance from the eye would dictate; and the aid of the eminent professional sculptor would only be necessary in the preparation of minature clay models, from which all the grandeur of form and greatness of style that could be put into them, all the qualities appreciable at the height from which they would be seen, could be translated by superior stone or marble masons into the solid material.

I need not enlarge upon the humanising and elevating influence upon the general mind that such a work is calculated to exert when thus complete, rejoicing in the potency of symmetrical grace and the beauty resulting from the full union of architecture and sculpture. Let the latter be rightly conceived and treated,—let it be employed to embody, not Greek or Roman legends, as it has too often been, but ideas and images drawn from our own history and poetry, and with which the English and Christian mind has sympathy, and the whole would stand forth in its architectural chasteness and artistic significance, a power for good, for discipline and refinement of humanity which few now dream of, but which it is the mission of art to accomplish, and failing which, it is but a costly and culpable luxury.

The subject out of which this has arisen I brought a fortnight ago before the public with extreme reluctance, and not till the common sense of the people, as well as the art of the architect, was insulted by forms which, should they remain, will remain as laughing stocks, and to which a couple of decapitated statues, or the two detached legs of a colossus, reared on the same spot, would scarcely be a parallel in absurdity.

SAMUEL HUGGINS.

*Liverpool, Sept.* 1, 1854.

## THE COMBUSTION OF COAL AND THE STRUCTURE OF FURNACES.*

THEORY and practice are commonly far apart, and various branches of science are seldom successfully applied by the same individual. The theory of combustion has been studied by some very eminent philosophers, and is laid down in every text-book, and yet it certainly enters but very little into the minds of those who fashion furnaces for consuming fuel, or of those who have the feeding of them. Mr. Charles Wye Williams, whose former labours were reviewed fourteen years ago in this *Journal*, claims the merit of having first made the theory harmonise with the practice, or in the words of Sir Robert Kane, has been "the first to place this subject in its important and just aspect." Beyond this Mr. Williams claims little, though he has certainly been among the most zealous advocates of improvement; and this is shown even to the present time by the issue of an improved edition of his book, or rather of a new book. Although the author of some important inventions, Mr. Williams is at present a disinterested advocate, as his patent of 1839 has expired. He has the enthusiasm of an author and an inventor, which is stronger in its influence than pecuniary interest; and he has, besides, the prestige of his high character and great success in the undertaking which he has conducted.

It was as one of the managers of the great company for Irish steam navigation, that Mr. Williams was led to consider the operation of the marine engine, and he has caused many important experiments to be performed, besides publishing the results of his own observations. It was as early as 1823, that Mr. Williams first gave his attention to the subject. Marine engines have naturally engaged him to a greater extent, but he has applied the same principles to the land engine and the locomotive. Taking up peculiar and practical points, of importance to the engineer, we think it desirable that Mr. Williams's views should come under consideration on the fitting occasion of their promulgation in a more comprehensive form.

The work as now arranged resolves itself chiefly under two parts—first, as to the theory, and second, as to the practice; and under each the various divisions are systematically considered in separate chapters, with appropriate illustrations. In a subject so comprehensive, and which is to a great extent controversial, it is difficult to go over the whole ground taken up by the author, and we must, therefore, limit ourselves to a more general notice of his opinions, and to a particular portion of the work.

James Watt, whose attainments in science were as extensive as the range of his inventive genius, did not allow the subject of combustion to escape him, and indeed it formed the ground of one of his patents. The state of chemical science was, however, in the last century so little advanced, and particularly with regard to the gaseous elements, that Watt was able to do but little. He recognised the error, rather than the cause or the remedy; nor is this surprising when we remember that he himself was one of the discoverers of the composition of water—a great stage in the progress of chemical science, and priority in which he contested with several brother philosophers. The gases occupied much of his attention, as the establishment at Bristol proves, and though he sought there a special application, it was dependent on the study of their general properties.

Many other practical men have given their attention to the same question, and many are the mechanical improvements which have been suggested and put in operation; but it is nevertheless true that our mechanical engineers have neglected the chemical relations of combustion, although it comes essentially within the domain of chemistry. Mr. Williams, M. Peclet, and others who have made a special study of these phenomena, necessarily claim a greater share of our attention. It is on the conviction of the neglect of practical men, that Mr. Williams begins with the elements, and considers the volumes and weight of the several combinations; and it is necessary to do this, because the ordinary perusal of a chemical work does not make a deep impression, nor convey the exact idea. One chief object is to point out the quantity of atmospheric air requisite for combination with the several gaseous compounds. The combinations of carbon are of the more importance, because the combination called carbonic oxide is one very readily produced, and is very little attended to; whereas it is requisite this oxide should not be produced during combustion, nor any other form but carbonic acid. In discussing these points, Mr. Williams rests on the authority of the most eminent chemists, and the only novelty is the form in which he places them before practical men, but this, in a practical point of view, is a great thing.

While ten cubic feet of air are required to supply two cubic feet of oxygen to effect the combustion of one cubic foot of coal gas, it is an essential consideration that the air should not be vitiated nor deteriorated, and yet under the ordinary arrangements the air requisite for one part of the operation has been already deoxygenated in the previous stage. In this respect Mr. Williams strongly controverts the theories of Mr. Tredgold, and particularly his recommendation to pass the whole supply of atmospheric air through the ashpit. Mr. Williams contends that one portion of air shall be applied to the carbonaceous element in combustion, and another portion to the gaseous products. He is a great advocate for the supply in jets (as instanced in the accompanying engravings), or the Argand principle. Mr. Williams very pithily

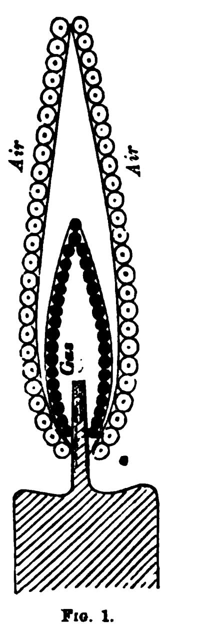



FIG. 1.

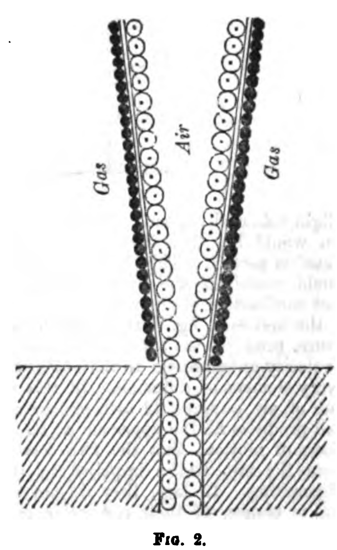



FIG. 2.

observes, that it is too readily taken for granted that if air by any means be introduced into the fuel in the furnace, it will as a

* 'The Combustion of Coal and the Prevention of Smoke chemically and practically considered.' By C. WYE WILLIAMS, Esq., Assoc. Inst. C.E. London: Weale. 1854.

matter of course mix with the gas or other combustible, in a proper manner, and assume the state suitable for combustion, whatever be the nature or state of such fuel; whereas, it may just as well be assumed that bringing together given quantities of nitre, sulphur, and charcoal, in masses, will constitute gunpowder.

"With reference to the *mode* of introducing the air, (says Mr. Williams), it is not a little remarkable (so slow is scientific progress when opposed to established custom) that many, to the present, overlook, or even dispute the difference in effect, when it is introduced through *one*, or *numerous* orifices. In illustration, then, of the effect of introducing the air *in a divided form*, let us take the case of a boiler furnace of modern and approved form, where the air enters by a *single orifice*, and compare it with that shown where it enters through 100 or more orifices.

In the first example (if the body of air be not too great), the effect may be favourable, to some extent, in preventing the generation of dense smoke. Inasmuch, however, as the quantity of air thus introduced, is chemically inadequate to the combustion of the gas, much of the latter must escape *unconsumed*, though not in the form of smoke, but *other force*,—*that other force* is just what is here required. Thus, in the present instance, we must either change the direction of the current of the air, *or give it the right direction from the beginning*.

Now, instead of a single aperture, let the air enter through a hundred or more apertures, as in fig. 4. Here the force and direction of *the current* will be avoided, and the required diffusive action produced on passing the bridge. Instead of the refrigeratory influence of the air, as in the first case, there will be a succession of igniting atoms, or groups, which Sir H. Davy calls, 'explosive mixtures,' each producing combustion with its high temperature. These are distinctly perceptible from the sight holes at H.

The same results will follow, whether the single or numerous orifices are placed at the *door*, or at the *bridge end* of a furnace, as in fig. 5. In this case, the diffusion will be more immediate and effective.

On this point it may be well to notice the oft-repeated fact, that the avoiding dense smoke may be obtained by leaving the fire-door *ajar*. Now, so far from this being a discouragement, or argument against the use of numerous small orifices, it absolutely confirms both the principle and practice; for, if allowing a *given quantity* of air to enter in a thin film at the edge of the door have a good effect, we are thereby encouraged to allow the *entire complement* to enter by other and *more*

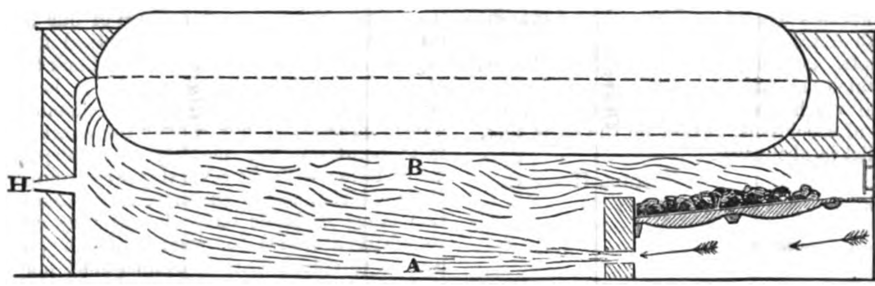



FIG. 3.

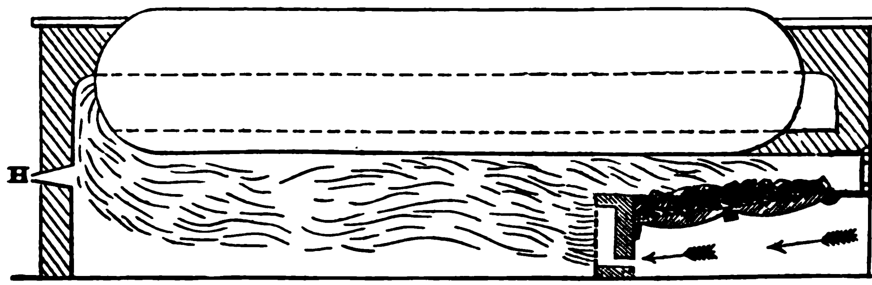



FIG. 4.

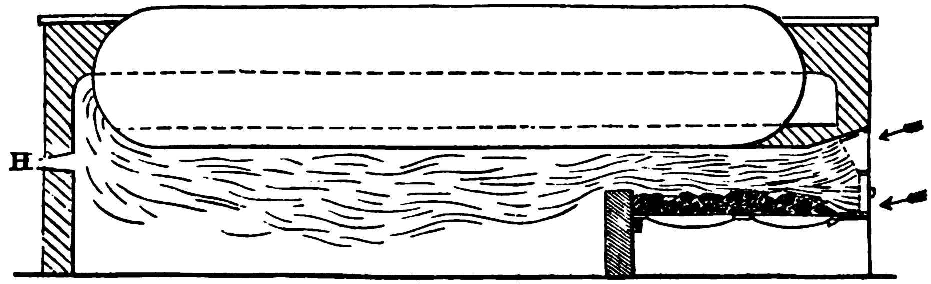



FIG. 5.

as a light coloured vapour. In such case, however, the inference usually drawn would be, that the area of admission was sufficient, and the combustion perfect. This, however, would be erroneous; besides, that it would constitute the mere non-appearance of smoke as the test of perfect combustion of the gas.

In the first case, fig. 3, the body of air, by passing through a single aperture, produces the action of a strong current, and obtains a direction and velocity antagonistic to that *lateral motion* of its particles which is the very element of diffusion. In this case, passing along the flue, the stream of air pursues its own course at the lower level A, while the heated products fill the *upper one* at B. It is here evident, according to the laws of motion, that the two forces, *acting in the same direction*, prevent the two bodies impelled by them (the air and the gas) from amalgamating. In fact, they do not come into contact, except in the strata, or planes, of their respective proximate surfaces. The cooling influence of the air, however, goes on in the flue, and produces a result the reverse of what was then most desired. In this case, the velocity of the current is opposed to the desired diffusion; and as, by the laws of motion, matter cannot change its direction unless by the introduction of *some* *numerous films* or apertures. If, indeed, allowing the door to be *ajar*, with an opening of one inch, were sufficient for the admission of *the entire volume* required, nothing further will be desired. The moment, however, the aperture is enlarged by opening the door wider, to allow that required volume to enter, the injurious and cooling influences of the body and current of air become self-evident, and the result confirmed by the reduced temperature in the flue, as indicated by the pyrometer.

Of the advantageous effect produced by *mechanical agency*, in promoting immediate diffusion between the air and the gas, the following experiments are quite conclusive.

Let figures 6, 7, and 8, represent each a tin apparatus with its glass chimney, similar to the ordinary Argand burner,—the gas is admitted the same way in all three—the difference to be noted is, *in the manner in which the air is admitted*. In all these cases, the quantity of both gas and air was the same.

In fig. 6, no air is admitted from below; and the gas, consequently, does not meet with any until it reaches the top of the glass, where it is ignited, producing a dark smoky flame.

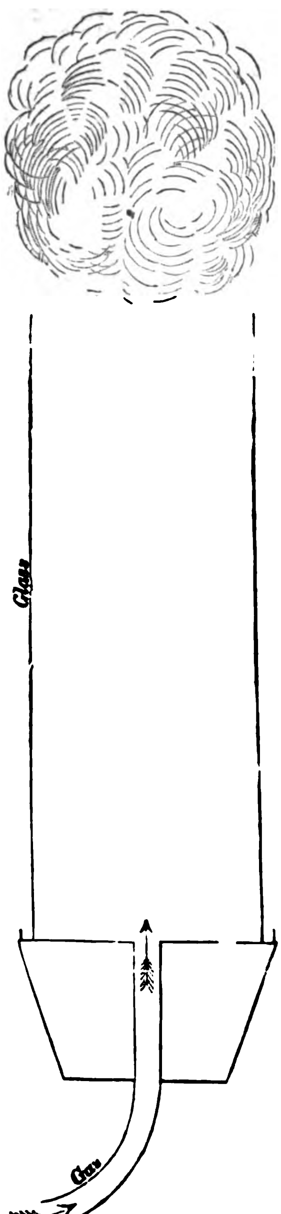



Fig. 6.

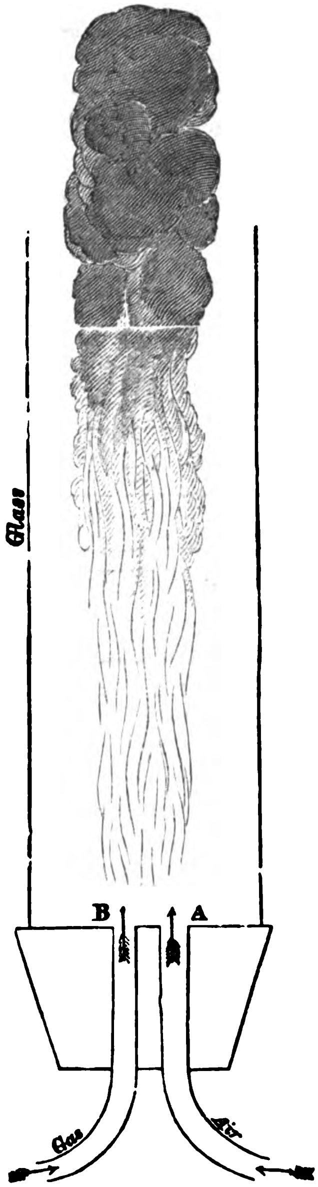



Fig. 7.

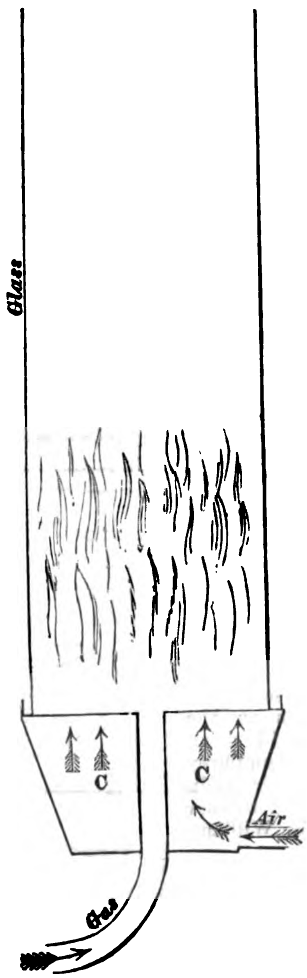



Fig. 8.

In fig. 7, air is admitted from below, and rises through the orifice at A, concurrently with the gas at the orifice B. On being ignited, one long flame is produced, of a dark colour, and ending in a smoky top.

In fig. 8, the air is introduced from below, and into the chamber C, C, from which it issues through a perforated plate, like the rose of a watering pot; thus producing immediate mixture with the gas. On being ignited, a short, clear, and brilliant flame was produced, as in the ordinary Argand gas burner.

The *heating powers* of the flames were then tested, by placing a vessel of cold water over each. When over fig. 7, it required 14 minutes to raise the water to 200°, whereas, over fig. 8, it reached 200° in 9 minutes.

Now, the difference of effect produced in those three experiments corresponds with what takes place in furnaces and their flues, when the air is excluded, and when it is admitted through a single or through numerous orifices.

Of the importance of *mechanical agency*, in promoting the rapid diffusion or mixture of the air and the gas, the modes adopted on the continent for rendering the coke gas, or *carbonic oxide*, available, are conclusive and instructive.

M. Peclet has given ample details of the mode of effecting the combustion of this gas (the existence of which has, for a long time, been practically ignored in this country), in the manufacture of iron, and even in the puddling furnaces, where the most intense heat is required.

M. Peclet states that the process at Treveray, in France, (see figs. 9 and 10) is preferable to that adopted in Germany, and for the following reasons, which are quite to the point of our present inquiry.

First, the air and the gas are better incorporated; secondly, the relative quantities of the gas being brought into contact with the air are more easily regulated; thirdly, combustion is effected by the introduction of the smallest excess of air.

In the apparatus, as shown in the section, fig. 10, fifty jets of air issue, each in the centre of fifty jets of the gas (carbonic oxide), led from the cupolas of the melting furnaces. On examination of the process here exhibited, the mixing and combustion, it will be seen, takes place *on the instant*, and before the flame and heat enter the chamber of the furnace at F. By this arrangement, M. Peclet observes, 'that the highest temperature that the arts can require is here obtained.' It is strange that the practical and commercial value of this gas, which is so wastefully expended at our manufactories, at the summit of the cupolas, but so well understood, and economised in France and Germany, is only just now being recognised in this country."

Another experiment on the operation of the jet principle is illustrated in the following extract:—

"The main object being the introducing the air in a divided state to the gaseous atmosphere of the furnace chamber, the following experiment was made:—The centre bar of a boiler, 4 feet long was taken out, and over the vacant space an iron plate was introduced, bent in the form as shown in fig. 11.

Here, the upper portion of the bent plate, projecting 3 inches above the fuel, was punched with five rows of half-inch holes, through which the air issued in fifty-six streams. Adequate mixture was thus instantly obtained, as in the Argand gas burner; the appearance as viewed through the sight-holes at the end of the boilers, being even brilliant, and as if *streams of flame* instead of *streams of air*, had issued from the numerous orifices. It is needless to add, that nowhere could a cooling effect be produced, notwithstanding the great volume of air so introduced.

This led to the enlarging the door-end of the furnaces sufficiently to admit the required number of apertures and full supply of air; an arrangement which has been for years in successful operation, both in marine and land boilers.

In practice, the great difficulty lay in adapting the plan to marine boilers, the doorways of which are made so contracted, as to render it impossible to introduce the required number of half-inch orifices, as hereafter will be shown."

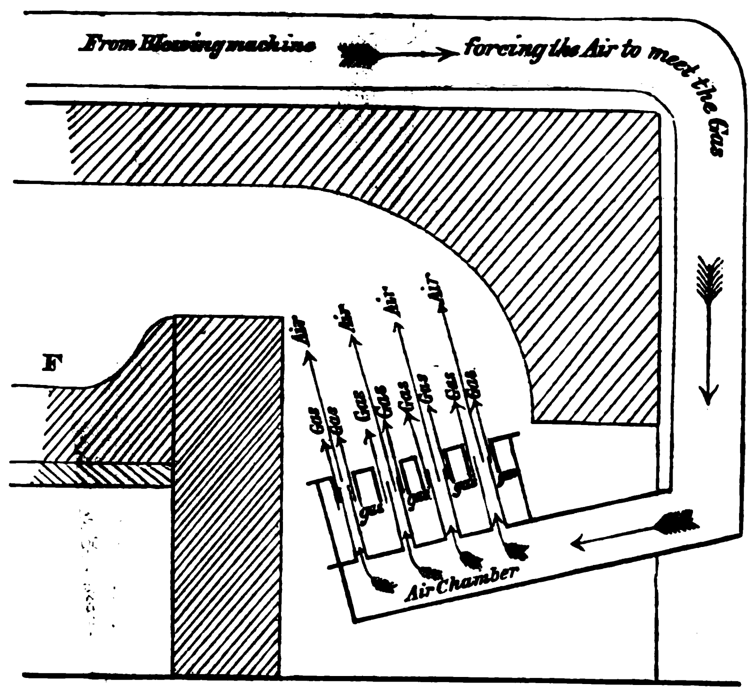


Fig. 9.

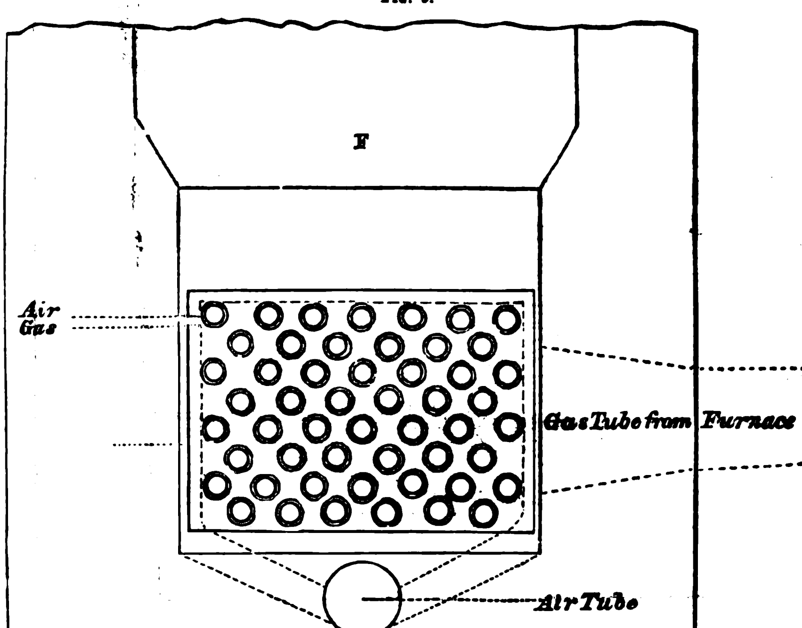


Fig. 10.

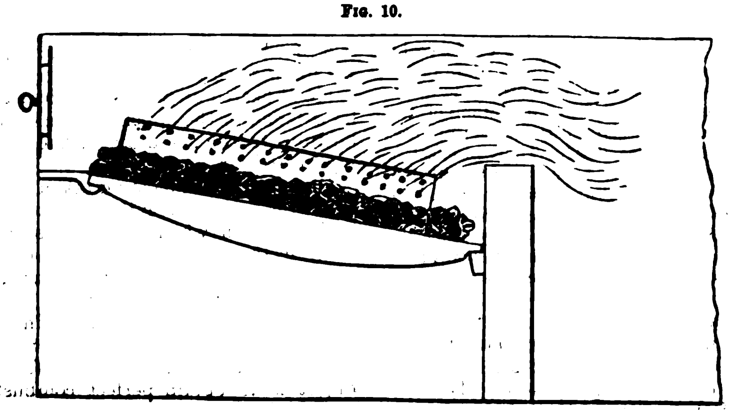


Fig. 11.

In the course of some investigations on the principles laid down by Sir Humphrey Davy, and their application to the tubular boiler, Mr. Williams observes:—

"On examination of what passes in furnaces *using coal*, we see the direct connection between its effect, and what Sir H. Davy so clearly points out as the means of *extinguishing the flame*. On looking into a *flue boiler* from the back end, a body of flame will be seen flashing along from the bridge, and if air be properly introduced, extending a distance of 20 to 30 feet. This is the appearance which has to be sustained *until the process of combustion be completed*, if we would have the full measure of heat developed.

On the other hand, looking into a *tubular* boiler, across the smoke-box, the light of the flame may be seen through the tubes; but on entering their orifices, or at a short distance within them, it will appear to be suddenly cut short and extinguished and converted into smoke, as shown in fig. 12.

The distance, then, to which flame will penetrate tubes, *before being extinguished*, will depend on the rapidity of the current, — the size of the orifices, — and the quantity and character of the gaseous products, *entering in company and contact with it*. These products are, from

Coke . { Carbonic Acid and Nitrogen.
Gas ... { Carbonic Acid, Nitrogen, and Steam.

Here we have the very incombustible gases referred to by Sir H. Davy, —not even in small, but in very large quantities, —forced into the most intimate possible mixture with the flame. The result necessarily must be, the reduction of its temperature, and consequent extinguishment.

Impressed with the importance of the connection between temperature and ignition, Sir H. Davy dwells on the fact, and repeats, that 'flame, whether produced from the combustion of *large or small quantities* of explosive mixture (gas and air), may always be extinguished or destroyed by *cooling agencies*; and *in proportion to the heat required to carry on combustion, so it is the more easily destroyed*.'"

Mr. Williams does not apply these remarks to those locomotive boilers where coke alone is used. He particularly discriminates between the various constructions of engine, and the various kinds of fuel employed. He says:—

"In speaking of the evils of the tubular system, these remarks have no reference to its application in locomotive boilers, where *coke alone* is used, and for this self-evident reason, that no hydrogen-carbon gas or fuliginous flame has there to be encountered. In the tubes of the locomotive there is, in fact, no chemical or practical reason why the heat may not be abstracted from the products with the greatest rapidity.

With reference to the size and sectional area of the tubes, we even deceive ourselves as to what that area practically is. When, for instance, it is intended to give an area of 2 or 3 inches, it will not be sufficient merely to provide tubes of 2 or 3

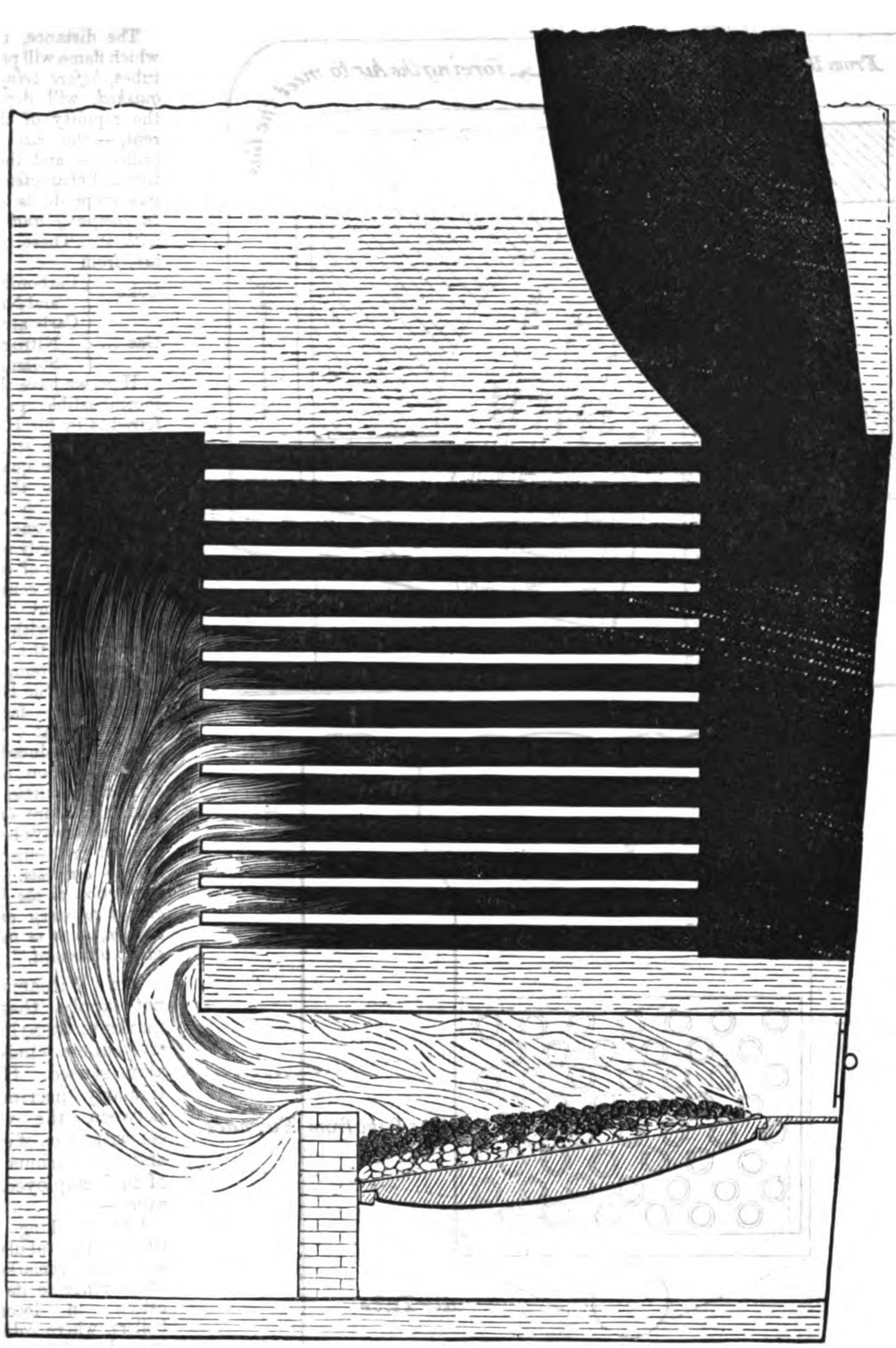


Fig. 12.

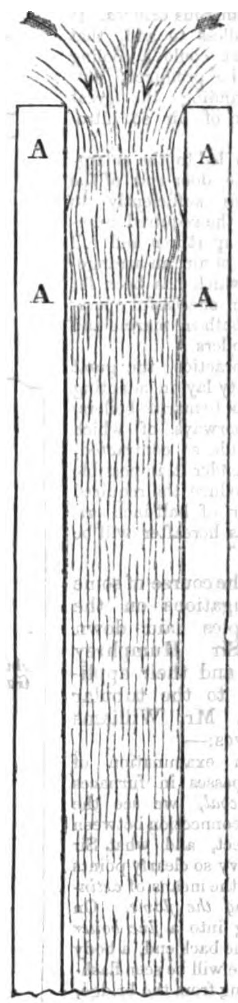



Fig. 13.

inches diameter. Allowance must be made for the effect produced by the rapidity or *pressure* of the body (whether it be flame, gas, air, or water), forcing an entrance into a restricted orifice. The true and available area, that which directly influences the mixing operation of the several bodies simultaneously forcing themselves through the orifices, will then be, not as at A, in fig. 13, but as at A′. Thus, in effect, a tube of 3 inches of internal area will practically have one of but 2¼ or 2 inches, and so in proportion to the size of the tube, and the amount of pressure exercised by the current. So little, however, has this been considered, that not unfrequently the ferrule, or iron ring by which the tubes are fastened to the face-plate, is inconsiderately placed *within their orifices*; thus still more seriously contracting the working area."

A very important subject and one almost distinct, is that referring to the circulation of water in the boiler, and which as it is treated by Mr. Williams at length, cannot fairly be comprised in the brief space we could now give to it. There is likewise a copious discussion of the merits of the tubular system, and Mr. Williams objects to its application for marine purposes He likewise enters on an investigation of the doctrines as to the value of heated air for feeding furnaces of boilers, and here again he is found in the opponent ranks, and is consequently in direct hostility to the patentees of the numerous inventions for applying heated air.

One ground of objection taken by Mr. Williams to the tubular system is grounded on the generation of a large quantity of water in furnaces in which coal gas is produced and consumed, which being in the form of steam becomes the largest product of that combustion. This results from bituminous coal containing from 5 to 6 per cent. of hydrogen.

The smoke question is only incidentally and collaterally discussed, because Mr. Williams considers that instead of attention being directed to contrivances for consuming smoke, the chief object is to obtain perfect combustion, when no smoke will be produced.

There is scarcely a portion of a subject so important and so difficult, and we may add so perplexing, to the practical man, that Mr. Williams has not elaborately and carefully treated. That of DRAUGHT is one essential to the well-working of the steam engine, of whatever class, and we are tempted to lay before our readers the views of Mr. Williams. This we shall do at some length, though were it not for the well-known zeal and liberality of Mr. Williams on a favourite subject, we should feel some delicacy in extracting so copiously from a work on which much labour has been bestowed, and the circulation of which at any rate interests the reputation of the author, even where it is not one of profit. We must, however, trust to his motives and our own to obtain his excuse.

In treating this branch of the discussion, Mr. Williams has frequently availed himself of the labours of M. Peclet, an authority to whom we have had many occasions to refer in the pages of this *Journal*. Mr. Williams observes:—

"The draught, or current of air passing through a furnace, is occasioned by the difference in weight between the column of air within the chimney, and that of an external column of the same proportions,—the 'ascent of the internal heated air,' as Dr. Ure observes, 'depending on the diminution of its specific gravity,—the amount of unbalanced weight being the effective cause of the draught.' Since, then, this levity of the inside air is the result of increased temperature, the question here for consideration is, how that temperature may be obtained with the least expenditure of fuel.

In marine boilers numerous cases of deficiency of draught will be found to arise from an injudicious arrangement of the flues, and the conflicting currents of the heated products within them.

Notwithstanding the importance of the subject, still but little attention has been given to the causes of these currents and deficient draught. M. Peclet having examined the subject with great care and practical research, his details are so copious, and his remarks so much to the point, that it will be well to give them due attention, and the more so as the subject has not hitherto been examined by any writer in England.

Among the inconveniences experienced, a prominent one may here be mentioned, as being of frequent occurrence, namely, a deficient draught in the side or *wing furnaces* of boilers.

M. Peclet observes, 'Where several tubes or flues open into one common flue, the currents are continued beyond their orifices, and by their mutual action, affect or modify their respective forces. If, for example, two flues A and B (see fig. 14) enter the common flue C, by orifices *opposite each other*, the influence of their currents on each other will be *nil*, *if they have equal rapidity*; because the whole will pass as if they had struck against a plane fixed between them. If, however, the currents be unequal, *that which has the greatest rapidity will reduce the speed of the other*, and more or less have the effect of closing the orifice through which the latter flowed.'

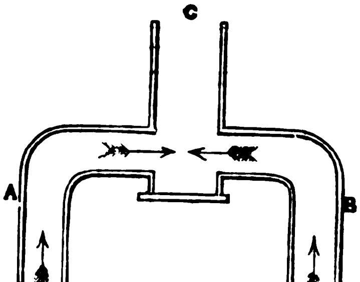


FIG. 14.

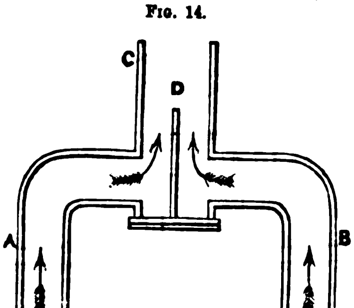


FIG. 15.

'So many proofs of this,' he adds, 'may be adduced, as to put the fact beyond doubt.' 'These streams of air,' he continues 'in this respect, act on each other as streams of water. It is already known by the experiments of Savart, that where two streams of water of the same sectional area, act in opposite directions, and that one of them has even but little more speed than the other, the latter is pushed back, and the influence felt up to its source. The result of this collision in the flue may be avoided by the diaphragm D (fig. 15).' Such conflicting currents may be found in almost all marine boilers, yet pass unnoticed, even where the draught is manifestly deficient in consequence.

Again, 'phenomena of the same kind will be produced where the courses of two flues are at *right angles to each other*, as in fig. 16. These effects may also be avoided by the diaphragm D (fig. 17).' This also is of frequent occurrence, and seriously affects the general draught, as will hereafter be shown.

Again, 'Where the chimney or flue is common to several furnaces, the arrangement should be such that the streams, or currents of heated gas, should not interfere with each other. Fig. 18 represents the arrangement that should be adopted in such cases.' It is needless to observe how frequent this state of things occurs, and how little attention is given to it.

FIG. 16.

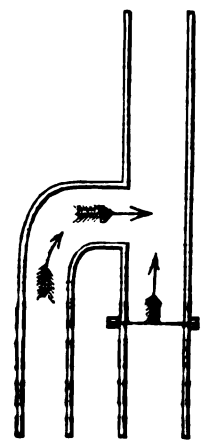
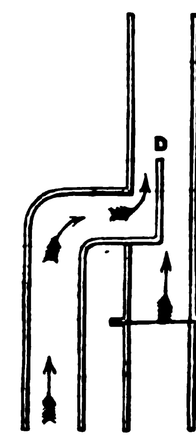


FIG. 17.



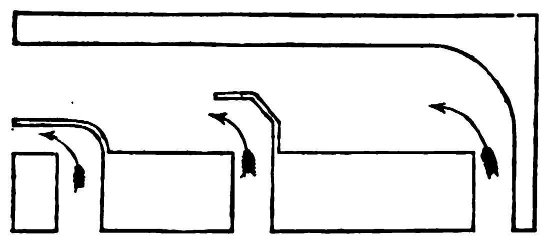



FIG. 18.

'So, where a current of hot products issues horizontally into a chimney, it may happen that its draught would be *entirely destroyed*, if the rapidity of such current was considerable, as it would then have the effect of shutting the chimney like a damper.' He then describes what occurred at a soda manufactory, with a chimney for general draught, which he had to construct, and which was also connected with a flue from another apparatus, as shown in fig. 19. In this case, 'the current from the one flue completely neutralised that of the other.' This he remedied by the partition P.

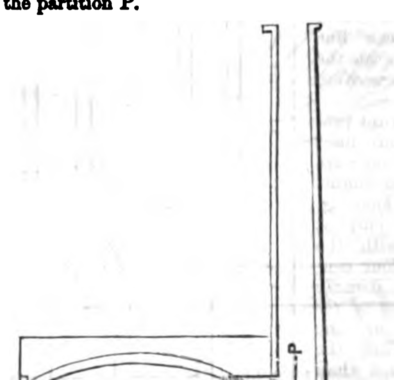


FIG. 19.

Again, where three flues enter a funnel from *three different points*, it is evident, he observes, that 'the diaphragms should be so placed as to leave each current an adequate section of the chimney,' as in fig. 20. The circumstance here referred to may be found to exist in almost all marine boilers. Rarely, however, is the interposition of these diaphragms thought of, yet numerous instances of the derangement of the draught, particularly of the wing boilers, must be within the knowledge of all engineers.

Let us now apply these judicious practical observations. The first boilers of the *Great Britain*, screw steamer, are in point. The arrangements of these boilers have already been noticed with reference to their impeding the due circulation of the water. We have now to consider them in respect to their influence on *the draught.*

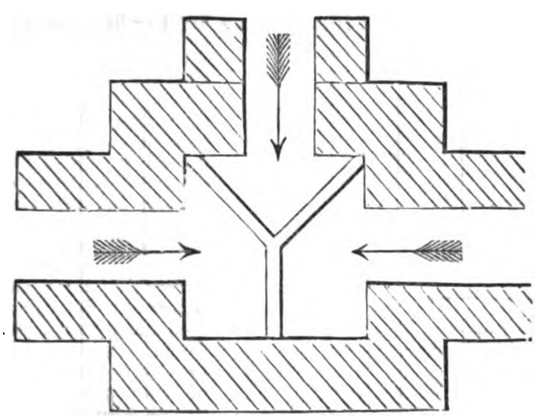


FIG. 20.

In these boilers, attention was given, almost exclusively, to two objects:—providing the largest possible amount of *fire grate areas,* and the largest aggregate of internal *heating surface.* As to the former, almost the entire area of these large boilers may be compared to an aggregate of furnaces. Nevertheless, there was no command of steam, and the engineer stated, that the wing boilers were unequal in draught to the centre ones. The deficiency of draught in the furnaces of the side boilers will easily be accounted for on examining the plan of the upper tier of flues, and the numerous collisions where the heated products from twenty-four large furnaces entered the funnels, as shown in fig. 21.

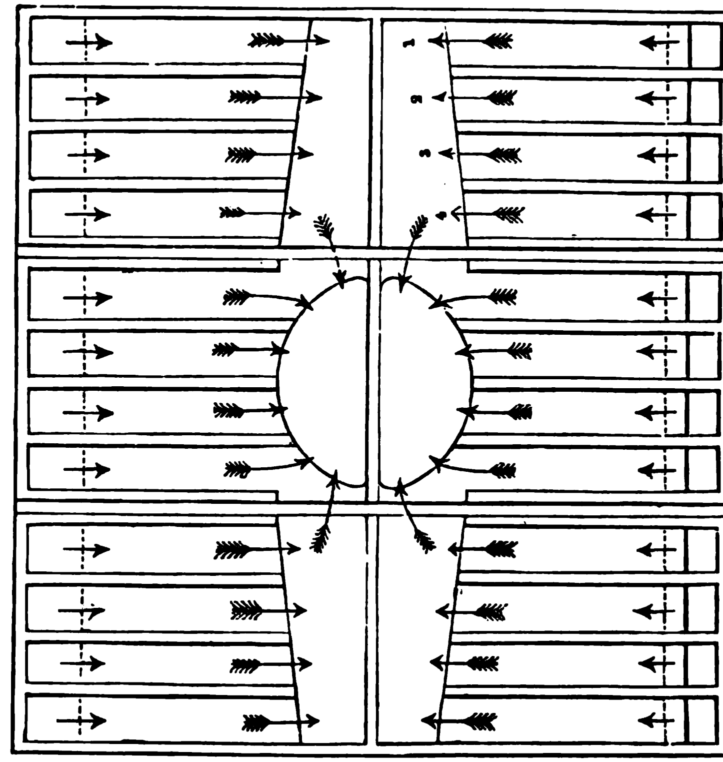


FIG. 21.

The flues from the four furnaces of each wing boiler, are here made to enter one common cross flue—each thwarting the current of the preceding one. No. 1 being checked by No. 2—which crosses it at right angles—which, in its turn, was checked by No. 3, and so on—the same mal-arrangement taking place in each of the sixteen flues of the four wing boilers. These, it will be seen, are the direct cases adduced by M. Peclet, where the products and current from one flue act as a damper on the *draught of its preceding one.*

Again, the joint products of the four flues of each wing boiler are made to enter the funnel by a single opening, which is not only at *right angles* with the flues from the four centre boilers, but *directly opposite to those of the wing boilers* on the other side. Thus the flues of no less than eight furnaces, all entering by a single opening are brought into direct collision with those of the other four, and in the most certain way to affect the draught of all. Here we have a combination of the evils referred to by M. Peclet.

The case of the boilers of the *Great Liverpool,* is a still greater violation of the rules which should regulate the draught. Here, there being but a single tier of flues, the required

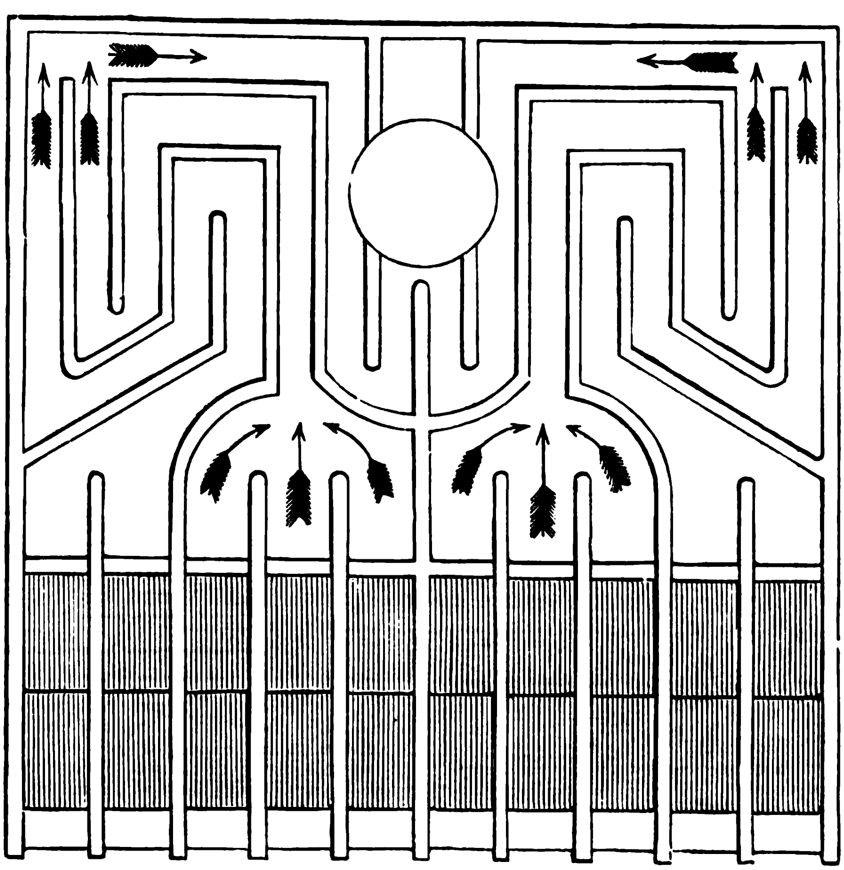


FIG. 22.

aggregate of *heating internal surface* was obtained by the labyrinth of windings shown in fig. 22.

In the first place, the flames from the three centre furnaces of each half of the boiler are forced into a single flue of but 13¾ inches wide, as shown by the arrows. Again, the gaseous products of each set of three centre furnaces, and which are necessarily the more powerful, are made to enter the single back flue at *right angles,* and across the current of products from the two wing furnaces, as shown by the enlarged view in fig. 23. It is scarcely possible to conceive a more direct case of collision, or a more effectual damper by the hotter and larger current from three furnaces, on the smaller current from the two wing furnaces. In these boilers, it is manifest that nine-tenths of the steam was produced by the plates in connection with *the furnaces alone,* and by a system of continued forcing; the long run of flues being filled with dense black smoke.

A considerable improvement was affected by constructing furnaces *in pairs,* as in fig. 24. This had the important advantage of rendering any interference with the supply of air unnecessary, by giving uniformity to the quantity of gas passing from the bridge to the flue; since, by firing the two furnaces *alternately*, the supply of gas is equalised on entering the flue from the bridges.

This plan, it will be seen, had the disadvantage of the *split flue* at the back end, where, as M. Peclet observes, *the hotter or stronger current will always neutralise the other.* In practice, a strong or hot current of gaseous products will not, voluntarily, divide itself, to meet the arrangements of the flues: the whole, or nearly so, will pass either to one or the other, in proportion to the temperature then in the flue, or to the length of the course each has to run to the funnel.

The plan shown at fig. 25 exhibited a great improvement in the former, and has for many years been found the most efficient in practice.

The plan as in fig. 26, was adopted with a view of dividing the gaseous products, and thus spreading the heat along a double surface. This, however, was quite defective, in as much as a gaseous stream cannot be induced to divide itself contrary to the laws governing the currents of fluids; the hottest and shortest course being always taken by the gaseous products.

The plan of a land boiler, as in fig. 27, is that of a still more objectionable effort to divide the current into two smaller flues, with the view of increasing the internal surface. Here, the flues, after passing under the cylindrical boiler, and returning through a central flue, is expected to divide itself into two streams, one to pass on each side of the boiler, on their way to the chimney. This is the case referred to by M. Peclet. A commission he observes, from the *Société Industrielle* of the Grand Duchy of Hesse, made a series of experiments to determine the influence of the circulation of the

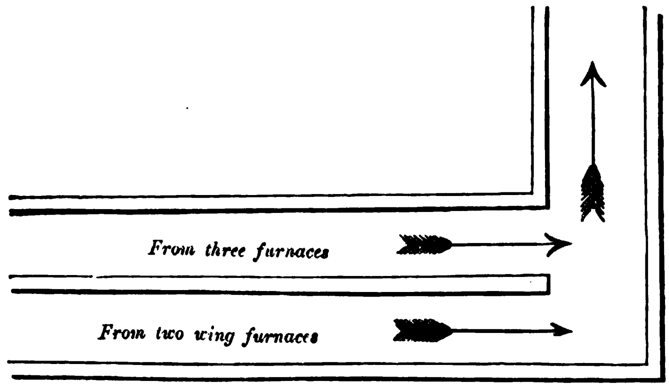



FIG. 23.

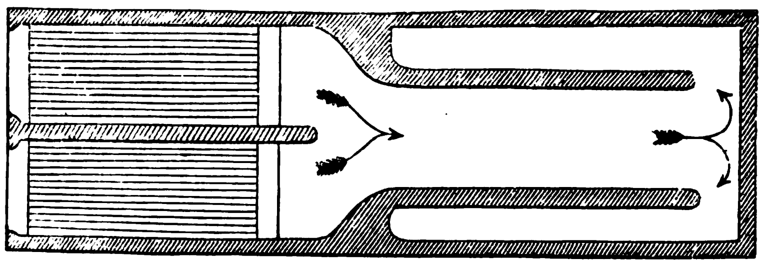


FIG. 24.

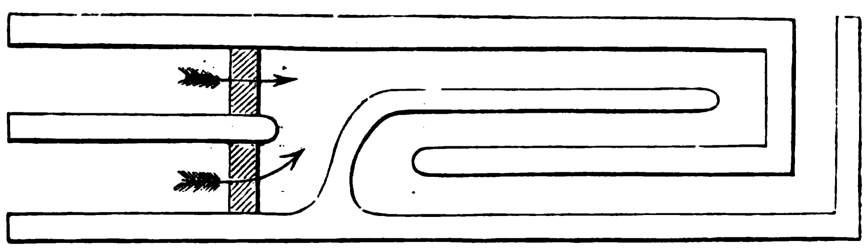


FIG. 25.

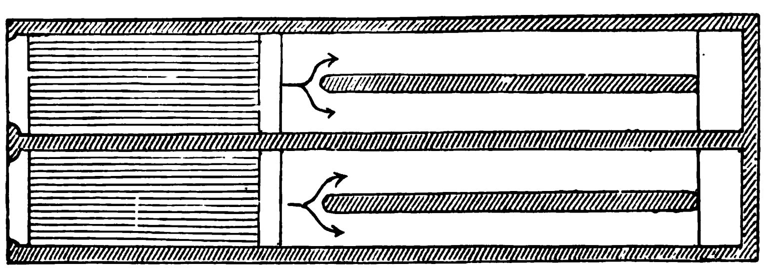


FIG. 26.

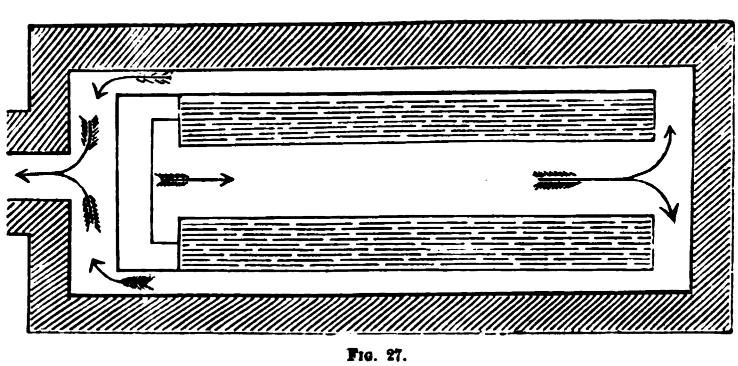


FIG. 27.

products of combustion round boilers. By these it was proved, that the flue passing round the boiler had a considerable effect on the amount of evaporation. It was also established, that if the products pass simultaneously by the two side flues, *they will not distribute themselves equally, and will only pass by that which presents the least resistance.**

On the *external* circumstances that influence the draught, M. Peclet adduces many proofs of the importance of avoiding any interference with the introduction of the air, by reason of the *direction of the wind outside the building.* This is a circumstance which has excited no attention from our engineers. In marine boilers, placed low down in the vessel, the direction of the wind with reference to that of the current entering the furnace, has often a considerable effect on the efficiency of the combustion. So, if the wind is opposed to the motion of the vessel or the reverse. The importance of this consideration is exemplified where the vessel contains two boilers, having their furnaces facing different ways. In such case, according to the direction of the wind, or the motion of the vessel, one boiler will have a better draught that the other.

That the relative direction of the wind, and the vessel, exercises a considerable influence, is proved by the fact, that the furnaces in some vessels will have a sufficient draught, and generate a sufficiency of steam, when going *head to wind*, but be deficient in draught when going *before the wind.* These circumstances merit more attention than is given to them."

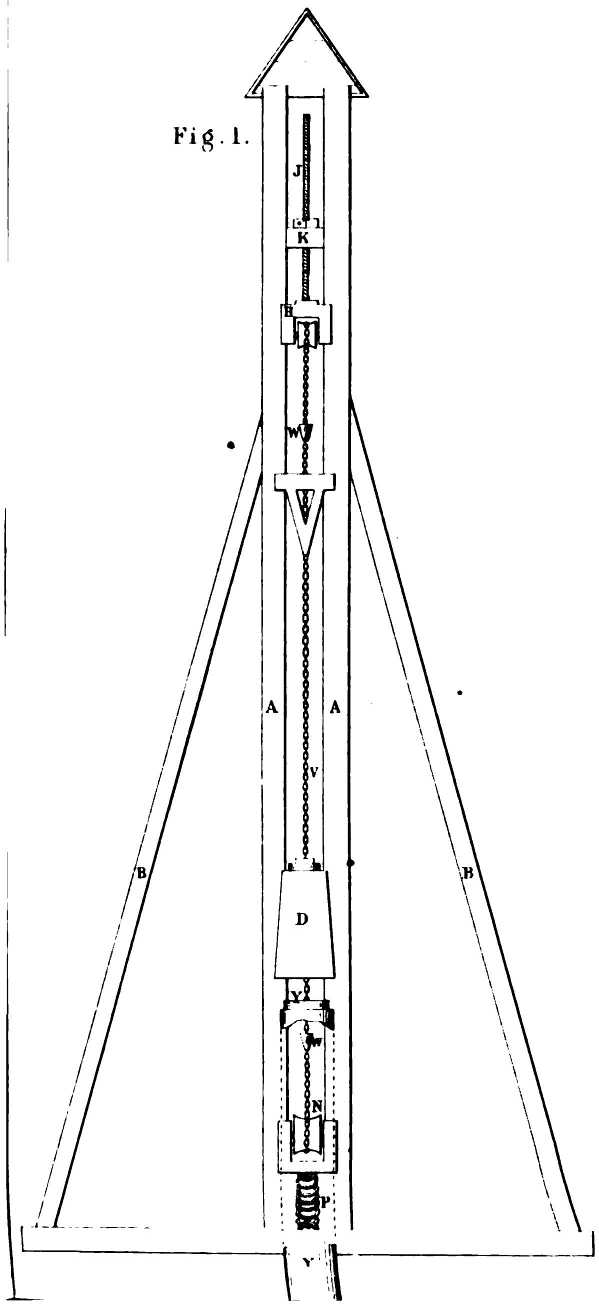
* "The hot air, after passing through the lower part of the boiler, returns to the front by a centre flue, passing to the chimney simultaneously by two side flues. By this arrangement, the heating surfaces are more available, but it is difficult to divide equally the hot air into the two side flues. Almost always the current is greater in one than in the other, and the hot air will pass *but through one of them.* In that case it will be necessary to have registers at the end of each."

# JOHN BOWER'S PATENT IMPROVEMENTS IN ENGINES FOR DRIVING PILES.

Drawings shewing working of Patent with Tackle at Fig. 6 & 7.

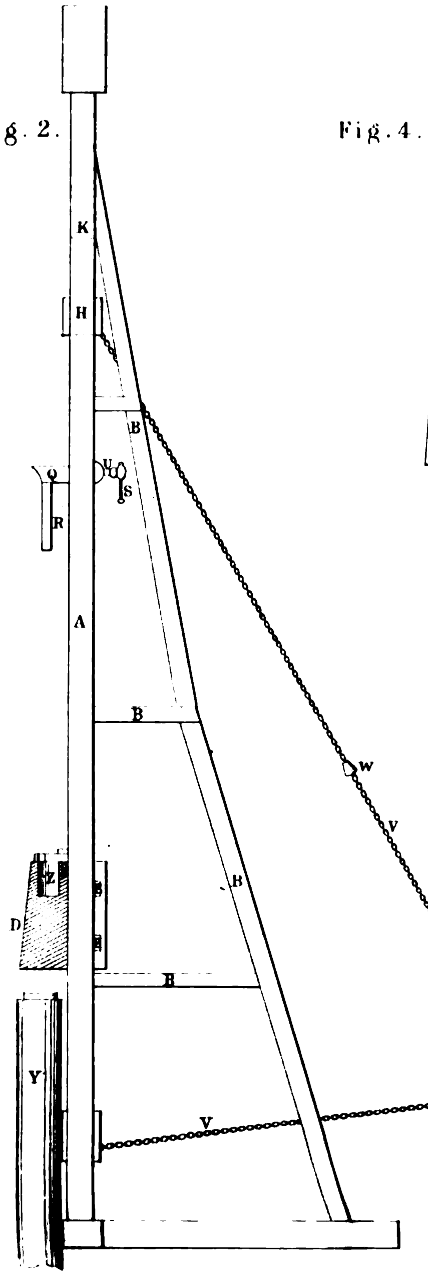
*Front Elevation.*

Fig. 1.



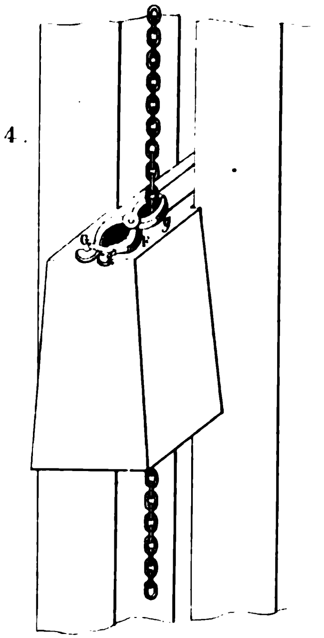
*Side Elevation.*

Fig. 2.



*Ram with Shears.*

Fig. 4.



*Back View shewing Capstan &c.*

Fig. 3.

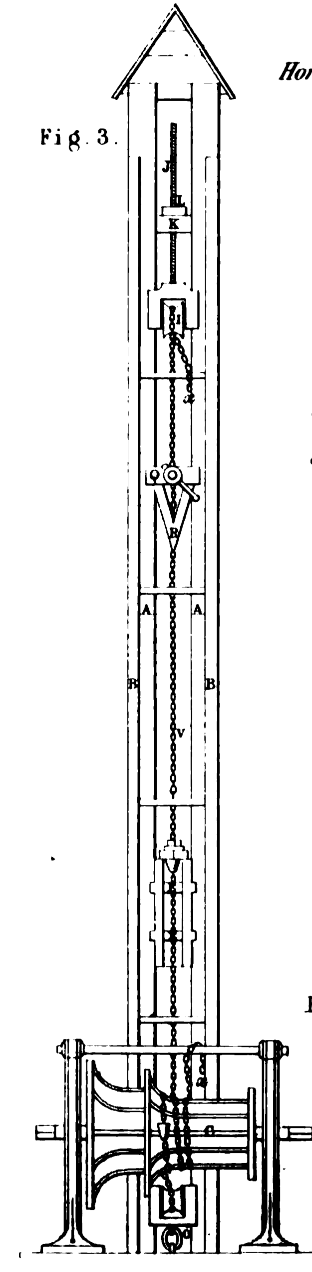
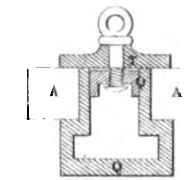


Fig. 5.

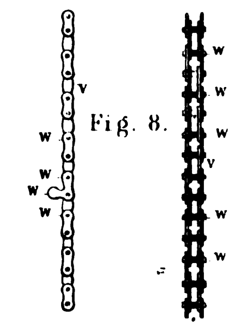
*Horiz.l Section through Trigger.*



Enlarged Sketches of Tackle.

*Pitched Iron Chain used with Cogs on windlass barrel to lift and detach the Ram by means of bent lever, Spring and Catch acted on by trigger as above.*

Fig. 8.



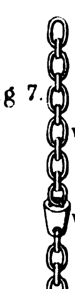
*Side View.* *Front View.*

*Rope of Copper Iron or Hemp.*

Fig. 6.

*Common Chain.*

Fig 7.



The views of Mr. Williams are strongly and heartily expressed, and many will differ from him, and the more particularly as he has discussed the opinions of every author on combustion, and the plans of every inventor; sometimes appealing to a corroborative proof, but often assailing the main or peculiar principle or distinction. Thus the voices and pens of many will be against him, and controversy will direct attention to the book; but it has merits which will secure for it at all times the weight of authority and the interest of practical and inquiring men. It is one of the most important contributions which has been made to this subject, because it comes from an able and independent man.

## PILE-DRIVING MACHINERY.

JOHN BOWER, *Patentee*, February 3, 1853.

(*With an Engraving, Plate* XXXIV.)

THE invention consists in the adaptation and application to engines for driving piles of a suitable tackle with stops, to be worked continuously by the barrel or capstan, such tackle being mounted in such a manner at the upper and lower part of the framework as to preserve the required degree of uniformity in the tension of the same during its working. The ram also is so formed, and has fixed to it a pair of spring jaws likewise so formed, that the tackle or endless rope or chain may pass through, but that the stops on the tackle may catch on a portion of the said jaws, and carry the ram upwards, until it is brought into contact with a wedge-formed trigger fixed in the framework; which trigger, in passing into a cavity in the ram, passes also between the arms of the jaws on the opposite side of their centre of motion from that at which they hold the said stops, and thereby opens the jaws and disengages the ram. Immediately on the disengagement of the ram, the spring or springs again close the jaws, so that they may be in the position to be caught by the next stop or projection on the tackle. The distance at which the stops are to be placed apart depends on the height of fall required for ram.

They should be equidistant, and always exceed the length of fall in a degree proportioned to the relative velocities of the tackle in rising and the ram in its descent as a falling body, so as to prevent the shock that would be occasioned by a stop coming in contact with the falling ram. The intervals or distances between the stops are so arranged as to bring a stop under the ram immediately after it has given the stroke or blow to the pile, which stop, by the motion of the barrel or capstan, carries the ram upwards until it is disengaged; and this operation is continued without interruption, the rotary motion in one direction of the working barrel or capstan being undisturbed throughout. In order, however, that the invention may be fully understood, we proceed to describe the accompanying Plate, which contains several figures, representing the different parts of an engine for driving piles, constructed according to the invention.

Fig. 1 is a front elevation of the engine; fig. 2 is a side elevation; fig. 3 is a back elevation of the same; fig. 4 is a horizontal section (on an enlarged scale) in the dotted line of fig. 2. A, A, are standards or guides for the ram in its ascents and descents; B, B, are stints, stays, and ladder; C, is a capstan, through which motion is communicated to the machine; D, is the ram, being formed with arms or projections *d, d* (which passes between the standards or guides A, A, the front part of the ram extending a short distance over the front of the guides); these arms or projections have holes in them through which wedges E, E, are passed behind the standards or guides A, A, and in this manner the ram is kept within the guides. These parts are shown in the detached fig. 4, also enlarged. F, F, in the same figure represent a pair of spring shears fixed to the head of the ram D, by a screw-bolt, washer and nut, or otherwise, so as to form a centre of motion for the shears, which are crossed at the centre, and extend in the form of arms F and *g*, confined towards the end by a spring or springs G, by which means the jaws *g, g*, and *ff*, are kept close until their arms *a, a*, are forced apart. The spring G, may consist of a band of vulcanised india-rubber, or a metal spring or springs of spiral or other forms, and may be variously applied to the arms F, for the purpose of closing the jaws. These arms F, lie over a recess or cavity Z, in the head of the ram, by passing into which between the arms F, the wedge-formed trigger (see figs. 1 and 2) forces the arms apart, and opens the jaws at the time required. V, is the tackle, with stops W, placed at suitable intervals thereon, as above described. This tackle may consist of a hempen rope with metal cones for stops, or a wire rope with like stops, as at fig. 6; or it may consist of a metal chain with stops, as fig. 7; or a chain of the form represented at fig. 8, with stops to catch on a bar in the jaws. I, is a pulley in the upper part of the standards A, A, over which the tackle V, passes. This pulley is mounted on a carriage H, which is capable of being adjusted to its required position by means of the capstan-nut L. M, is a pulley at the lower part of the standards A, A, under which the tackle V, passes. This pulley is mounted in a carriage M, which is susceptible of a slight degree of vertical movement, being connected to the lower end of a spiral spring P, or india-rubber band, now attached below (to the bar O, fixed in standards A, A); an additional use of these two pulleys I and N, is to regulate the tension of the tackle, and to obviate the necessity for shifting the engine as the work proceeds.

By means of the pulley I, mounted as described, the tackle is tightened or slackened, in order to secure the power of lift, and it may also be removed by the same means; but there is likewise a further use of the said pulley. In driving piles along the straight side of a cofferdam, and using the endless rope or chain above referred to, it would be found that the same length of tackle would not suit for driving more than one or two piles in the same row until the engine was shifted.

By means of the sliding-carriage H, however, the same tackle may be worked without alteration at variable distances within the range of the screw J. Thus, to increase the working distance, the carriage H, with its pulley must be lowered by the screw, and the engine moved forward; and to decrease the same, the carriage with its pulley must be raised by the same means, and the engine moved back. By means of the pulley N, mounted as described, the inconvenience of the slackening of the tackle consequent on the lifting of the weight, and of the shifting of the same in "singing," may be obviated. The tackle having been tightened by means of the screw attached to the pulley I, the carriage M, of pulley N, is drawn upwards so as to compress the spring P, tightly. Motion having commenced on the barrel on the first slackening of the tackle (from either lifting or singing) the spring P, exerts its force and produces the tightness required for effectual working.

Immediately afterwards the motion of the capstan tightens the tackle, and the spring P, yielding to the pressure upon it occasioned thereby, the carriage M, is drawn up to its first position, and thus the required tension is maintained throughout.

These pulleys I and N, may also be mounted in fixed bearings in the standards A, A, without the adjusting-screw J, and spiral spring P, but the arrangement above described is preferred. Q, is the trigger carriage or frame; R, is the trigger, which is fixed at its required altitude by the screw U, and passes through the plate T (see fig. 5), which is thereby secured at any required height at the back of the standards or guides A, A; the screw is turned by means of the vice-handle S. The length of the fall of the ram is regulated by the position in which the trigger is fixed in the standards.

The operation of the engine is as follows. The ram D, being in its place between the standards or guides A, A, and the tackle arranged as described, the latter is adjusted to a proper degree of tension by means of a screw J, belonging to the pulley I. On power being applied, and the capstan C, turned, the tackle V, moves freely upwards between the jaws *g*, until one of the stops or projections W, arrives under the said jaws, when the thicker part of the cone catches against the same, and being upon the under surface of the jaws, carries the ram.

This motion of the ram is continued until it arrives at the under part of the trigger R, which passes into the recess Z, in the ram, and its arms being wedge-formed, force apart the arms F, F, on the opposite side of the centre of motion of the jaws *g, g*, and cause the jaws to open suddenly, by which the stop at once loses its hold on the jaws, and passes through them, the ram thus disengaged falling freely on to the pile-head. As soon as the ram falls from the trigger, the pressure of the wedge-formed arms of the same against the arms F, F, of the jaws ceases, and the spring or springs G, again close the jaws *g, g*, in readiness to receive the next stop or projection W, on the tackle G.

The inventor does not mean or intend to confine himself to the precise forms and arrangement of the parts shown and described. The improvements may be applied with advantage to some pile-driving engines in ordinary use.

*Claims.*—1. The adaptation and application to engines for driving piles of an endless tackle with stops and suitable pulleys, together with a form and construction of ram capable of being raised to its required height, and allowed to fall at regular intervals, without interrupting the uniform course of the working barrel or capstan, as described; 2. The arrangement of upper and lower pulleys mounted in carriages, capable of adjustment by means of a screw and spiral spring, for the purpose of regulating the tension of the tackle and obviating the necessity for moving the engine so frequently during the course of the work, as described.

## SEWERAGE AND WATER SUPPLY OF KELSO.

*Report of* James Brunlees, C.E., Manchester.

In compliance with a resolution passed by the chief magistrates and commissioners of police, of the "Burgh" of Kelso, Mr. Brunlees has prepared "plans, sections, estimates, and a report for the sewerage of the town." We subjoin an epitome of the report, with brief necessary explanations, touching the locality. The desiderata contemplated in the report are—

I. An efficient system of sewerage effectual for the under drainage of the lowest buildings in the town, and embracing its entire extent; including, also, the drainage of suburban meadows, the present condition of which induces prejudicial atmospheric influences; and

II. A constant and copious supply of wholesome water, ample in quantity for public and domestic purposes, and available for use at the top of the highest buildings in the town. The governing considerations, in relation to the materials, dimensions, and character generally, of the works recommended in the report, have been economy, efficiency, permanent self-action, and durability.

Kelso is situated on the banks of the River Tweed, about 22 miles above Berwick, and nearly opposite the confluence of the rivers Tweed and Teviot. The water-course is from 400 to 500 feet wide, and contains a large body of water, passing at a moderately rapid rate. The population of the town is about 5000. Kelso presents a picturesque appearance, but is a very irregularly built town, and extends over considerably greater space in certain directions than the population might seem to indicate. The greater part of the town is built upon low-lying "Inch," with a gentle slope from the north bank of the river; a ridge of considerable elevation (the chalkheugh) running in a transverse direction from the Tweed, and abutting on its banks, divides about a fifth of the town, on the up-stream side, from the major portion.

The district is pleasant and salubrious; but the important sanitary advantages, which the site of Kelso places within reach, have not hitherto been realised, and the consequences of this neglect may be traced in the virulence of the attacks which have been sustained, by cholera and other pestilential scourges. The drainage of the town is extremely defective; it may be said, indeed, with perfect truth, that there is a total absence of anything deserving the name of a *system* of drainage, and the authorities have for a considerable time been fully alive to the vital importance of providing a remedy for this great defect. The sewage, and animal and vegetable refuse matter, which should be carried off by underground watertight channels, has been allowed for the most part to flow or stagnate on the surface, or has been collected in heaps, pits, or cesspools. The principal sewer, which runs alongside a number of houses, and which is very limited in extent, is a drain of 2 feet square, built of rough stones with open joints, and covered with flags which form the footpath.

The worn and imperfect joints of this drain afford a passage for constant streams of miasmata, which pollute the atmosphere; and the rude masonry of its sides and bottom permits the sewage to percolate, and actually ooze out in the houses in its neighbourhood. A considerable portion of the streets are nearly level, and many of them, from the absence of means of absorption for surface water, are submerged and impassable for a considerable time after a heavy rainfall.

The natural peculiarities of the site of the town suggests three divisions of sewerage—

(1.) The first division embraces the principal streets, and most compactly built part of the town, and about three-fifths of its extent. The aim has been to throw as much of the sewage as the levels permitted, into this division. The discharge for this main portion will be at the Bullet Loan, a point on the down-stream side of the town sufficiently remote to prevent the possibility of offence to the inhabitants by any exhalations from it. This division includes a main sewer from the Bullet Loan to the Coldstream-road, thence to the Coal-market, up the Wood-market, and through the south and west sides of the market place to near the Flesh-market in Roxburgh-street. Also another main sewer from the Coal-market to the top of the Horse-market, terminating on the east side of the market-place. This main and branches embrace about 1205 yards. It is proposed to construct them egg-shaped—the main 3 ft. 9 in. by 2 ft. 6 in.; the branches 3 ft. 4 in. by 2 ft. 3 in. The inverts to be of radiated brickwork set in cement, the sides and top arch to be of rubble. This form is preferred to secure an equable and rapid flow, and the combination of material is recommended for economy, bricks being expensive in that locality. The inclination of these mains is very favourable, being 1 in 250 throughout. The mains being placed sufficiently deep to drain the lowest buildings in the town, necessitates their being at a considerable depth from the surface (from 8 to 12 feet); but the uniform and rapid flow which will be secured, will effectually prevent silting or any deposit of material in the sewers, and this important advantage is an ample equivalent for the extra expense incurred from this circumstance. The subordinate sewers in this division aggregate about 2715 yards, and are to be of earthenware half-socketed pipes, varying from 9 to 15 inches diameter, as the areas to be drained and other circumstances suggest.

(2.) The second division embraces the upper part of the town, which is divided from the principal division by the intercepting ridge already referred to. The heavy expense which would be incurred in tunnelling this ridge, has prevented Mr. Brunlees from throwing the sewage of this into the principal division, which he would otherwise have done, discharging the whole by one outlet. The main sewer in this division will be a 21-inch barrel culvert of brickwork, about 46 yards long, with a discharge into the river at the bottom of Dispensary-lane.

To render the discharge inoffensive, the culvert will be supplemented by iron piping, secured by masonry, carried well out into the river for the immediate and complete dispersion of the sewage. The subordinate sewers in this division embrace about 1434 yards of earthenware pipes, from 9 to 15 inches diameter.

(3.) The third, or mill divison, is of an exceptional character, and the area drained by it is very small. It lies between the river and the lines of the first division, and consists of a few short and unimportant streets close to the Tweed, and having a direct fall into the stream. The levels necessitate the summary drainage of this small portion into the river at once, and this may be done without incurring the possibility of annoyance from the result. This division aggregates about 300 yards, and will be of 12 and 15 inch earthenware pipes.

The main and tributary sewers are laid in straight lines, as far as possible, with connecting curves of as wide radii as the situations permit.

The sewers throughout are calculated to carry off a rainfall of one inch per hour in addition to house drainage, so that submerged streets may no longer be feared.

The gradients of the pipe-drains are all remarkably favourable, varying from 1 in 250, to 1 in 10, the average being about 1 in 100.

The town is long and narrow, and most of the cross streets are short, and this circumstance has happily facilitated the endeavour to obtain throughout the most rapid inclinations possible.

Mr. Brunlees discusses in his report the value of sewage for agricultural purposes, its chemical elements, deodorisation, the best mode of treating it, &c., and recommends the construction of two covered tanks at the outlet of the principal division, each tank to be capable of containing a week's sewage. He fortifies this recommendation by quotations from the most distinguished chemical authorities, by statements of important illustrative facts, and by an estimate of the pecuniary result. Taking the value of the refuse from each inhabitant on this division, at the low figure of 2*s*. 6*d*. per annum, he estimates the net profit at nearly 300*l*. per annum, and this is exclusive of the liquid sewage. He proposes to construct these tanks on such a level as will give the greatest facility for loading from them, and for running off the liquid sewage. In relation to saving the sewage, but primarily and urgently on sanitary grounds, he recommends the substitution of waterclosets and soil-pans for privies and cesspools; and urges, that until the one kind of convenience is employed to the supercession of the other, the advantages of ample water supply, and an efficient system of sewerage, can only be very partially realised.

The suburban "meadows" Mr. Brunlees proposes to drain in the usual manner, cutting off the water-shed from the northward by a deep intercepting drain on the upper side of the meadows. By this means he believes that the producing cause of fogs will be removed, that the humidity of the locality will be materially diminished, and the temperature improved.

Water may be supplied to the town by three methods:—1st, by pumping from the Tweed; 2nd, by pumping the water that may be collected in the "meadows," afforded by the water-shed from the West Broomlands plantation, and the high grounds to the northwards; and 3rd, by gravitation from the River Eden at the top of Stitchell Linn. The last plan is recommended for adoption, on a full consideration of the efficient action of the works, the quantity and quality of the supply, the annual cost of maintenance, and ultimate economy.

Stitchell Linn is about 94 feet above the market-place. It is proposed to convey the water by pipes, in the ordinary way, to a service reservoir at the "Shoulder of Mutton Plantation," at a level of about 60 feet above the market-place. The supply would thus be constant, and at high pressure. The estimated supply is at the rate of 20 gallons per day per head for 6000 inhabitants, which leaves ample margin for flushing the sewers and other public purposes, as well as for increase of the population. The estimated cost of the sewerage, draining, and manure-tanks, is 3764*l*., and of the waterworks is 3473*l*.

The plans and estimates, &c., are based upon a minute and complete survey of the "Burgh," made for the express purpose.

## THE REPORT ON RAILWAYS FOR 1853.

By Captain Galton, R.E.

The length of new lines of railway sanctioned by the legislature in the United Kingdom during the year 1853, was 940 miles, which amount is very considerably greater than that sanctioned during any year since 1847. Of this amount, 589 miles were in England, 80 miles in Scotland, and 271 miles in Ireland.

Among the most important of the new lines in England appear to be the following, viz.:—A line from Strood to Canterbury, by which the communication by railway along the South bank of the Thames will be rendered continuous as far as the North Foreland. The Portsmouth Railway, by which a direct communication will be afforded between Portsmouth and the metropolis. An extension of the Midland Railway from Leicester to Hitchin on the Great Northern Railway, by which a second line of communication will be afforded from the Midland districts to the metropolis, and the Worcester and Hereford Railway, by which a more direct road will be opened between the Midland Counties and South Wales.

In Ireland the most important line would appear to be the Londonderry and Coleraine Railway, by which a direct route will be afforded between Belfast and Londonderry; and the Londonderry, Coleraine, and Sligo Railway, which will afford a direct railway communication from Sligo to Londonderry and to Dublin.

The total length of railway which has been authorised by Parliament to the end of 1853 is 12,688 miles. Of this number of miles 7686 have been opened for traffic, leaving 5002 miles to be completed; but the compulsory powers of 2838 miles have expired without being exercised, or the railways being opened to the end of 1853. The length of railways for the construction of which Parliamentary powers exist is 2164 miles. The length of railway opened previously to December 1843, was 2036 miles. The length opened in the year 1844 was 204 miles; in 1845, 296 miles; in 1846, 606 miles; in 1847, 803 miles; in 1848, 1182 miles; in 1849, 869 miles; in 1850, 625 miles; in 1851, 269 miles; in 1852, 446 miles; in 1853, 350 miles; making the total length then opened 7686 miles; of which 5848 miles are in England, 995 in Scotland, and 843 miles in Ireland. The length of narrow gauge railway, including the Irish gauge of 5¼ feet, is 6965 miles, of the broad gauge 626 miles, and of the mixed gauge 95 miles. The number of railway companies having single lines of railway at the end of 1853 was 97, the length of single narrow gauge lines, including the Irish gauge, 1543 miles, of broad gauge 112 miles, and of mixed gauge 53 miles—total, 1708 miles; of which 1135 miles of single line are in England, 132 miles in Scotland, and 441 miles in Ireland.

Of the single line opened at the end of the year 1852, 32 miles 46 chains in England, and 41 miles 76 chains in Ireland, have been made double during the year 1853.

The total length of new line which was opened during the year 1853 amounted to 350 miles.

Of the lines opened in England, the principal ones are—the Oxford, Worcester, and Wolverhampton Railway from Wolvercot to Evesham, by which the manufacturing districts near Birmingham, the town of Worcester, and the important agricultural districts between Worcester and Oxford are accommodated with a direct route to London; the Newport, Abergavenny, and Hereford Railway, by which a direct route is afforded from Birkenhead to South Wales; and the Thirsk and Malton, and Malton and Driffield Railways, by which railway communication is afforded to an important district in Yorkshire.

In Scotland the only line of importance opened for traffic was the Deeside Railway. In Ireland, the most important lines are the Waterford and Kilkenny, and Waterford and Limerick Railways, by which Waterford has been connected with the Irish railway system; and the railway from Killarney to the Great Southern and Western Railway.

All these lines of railway were inspected, previous to being opened for traffic, by officers of the Railway Department of the Board of Trade, who required the opening to be postponed in twenty-eight instances. The total number of inspections which were required to be performed by the officers amounted to fifty-eight.

Of the railways opened during 1853, twenty-five portions of railway, representing a total length of 298 miles, consisted of single line open at the end of 1853, viz., 1708 miles, was between one-fourth and one-fifth of the whole amount of railway open. It is to be observed that the length of single line open at the end of 1852 was 1485 miles, and at the end of 1851, 1307 miles. A single line of railway cannot be worked with safety except under special regulations, so framed as to prevent the possibility of engines or trains moving in opposite directions, from meeting on the single line; such regulations are, however, inconsistent with a large amount of traffic. In all cases of single lines opened during 1853, the regulations required generally either that the trains should be worked by means of one engine moving backwards and forwards over the line, or over particular portions of it; or that some particular man should be appointed to accompany the trains moving over the portions of single line. And in cases where the electric telegraph is in use, the regulations required were, that the persons employed to start trains should be distinctly responsible for ascertaining, before starting the trains, that the line is clear so far as the next station.

The amount of capital invested in railways at the end of 1852 was 264,165,680*l*., of which 161,400,256*l*. consisted of ordinary capital, 38,700,755*l*. of preference capital, and 64,064,668*l*. of loans. The amount of capital raised for railway purposes, in 1849, was 29,574,720*l*.; in 1850, 10,522,967*l*.; in 1851, 7,970,151*l*.; and in 1852, 16,398,993*l*.; thus increasing the amount invested in railways at the end of 1849 from 229,747,778*l*. to 264,165,680*l*. at the end of 1852. The amount of money which was raised by railway companies during 1853 has not yet been returned to Parliament; but it may be assumed not to have been less than that raised during 1852, and it is therefore probable that the whole sum raised by railway companies to the end of 1853 is not less than 281,000,000*l*., of which about 42,000,000*l*. may be assumed to have been preferential capital, and nearly 70,000,000*l*. would appear to have been borrowed on the security of the undertakings.

The number of miles of railway in course of construction on the 30th of June, 1853, was 682 miles, and the number of men employed on them was 37,764. The number of miles open for traffic at that date was 6512, and the number of men employed 80,409. The number of men employed on railways open for traffic was 9·5 per mile in 1852, and 10·7 per mile in 1853.

The total number of passengers conveyed on railways in the United Kingdom in the year 1853 amounted to 102,286,660; the number in 1852 had been 89,135,729. The total receipts from all sources of traffic amounted in 1853 to 18,035,879*l*., and in 1852 to 15,710,554*l*.

The receipts from goods have increased from 4,750,504*l*. in 1849, to 8,112,477*l*. in 1853, being an increase of from 1090*l*. per mile in 1849 to 1415*l*. per mile in 1853; and whilst the receipts from passengers in 1849 were larger than the receipts from goods in the proportion of 53·42 to 46·48, in 1853 the contrary was the case, viz., the percentage of the passenger traffic was 47·45, and of the goods traffic 52·55.

In Scotland the progress of traffic on railways has been similar.

The mean length of railway open during the year has increased from 795·5 miles open in 1849 to 987 miles open in 1853. The number of passengers conveyed in 1849 amounted to 7,902,228, and in 1853 to 10,999,224, which represents 9993 per mile in 1849, against 11,246 per mile in 1853. The relative number of passengers of each class conveyed would appear to have slightly varied, the number of first and third-class passengers having increased, and the number of second-class passengers having diminished, the number in 1849 being 720 first-class passengers per mile, 2035 second-class passengers per mile, and 6997 third-class passengers per mile, against 1107 first-class, 1971 second-class, 8165 third-class passengers per mile in 1853. The receipts from passengers having increased from 540,778*l.* to 697,712; or from 680*l.* per mile in 1849 to 713*l.* per mile in 1853; and the proportion of receipts from each class conveyed having been, in 1849, 149*l.* per mile for first-class, 196*l.* per mile for second-class, and 331*l.* per mile from third-class passengers, against 181*l.* per mile from first-class, 179*l.* per mile from second-class, and 345*l.* per mile from third-class passengers in 1853.

It would, therefore, appear that in Scotland the third-class traffic preponderates considerably both as regards numbers and receipts. There is also in the Scotch lines a preponderance in the receipts from goods traffic over the receipts from passenger traffic.

The amount received from goods in 1849 was 650,640*l.*, and in 1853 it was 1,068,016*l.*, representing 818*l.* per mile in 1849, against 1075*l.* per mile in 1853. The relative proportions of the two descriptions of traffic were, in 1849, passenger traffic 45·38, and goods traffic 54·62; and in 1853 the receipts from goods traffic amounted to 60·48 per cent. of the whole traffic.

The mean length of railway opened in Ireland in the year 1849 was 428 miles, and in the year 1853 it was 771 miles.

The total number of passengers conveyed in 1849 amounted to 6,059,947, or 14,142 per mile; and in 1853 it amounted to 7,074,475, or 9175 per mile.

The receipts from goods are also largely increasing, and they bear every year an increasing proportion to passenger traffic.

With respect to accidents, it appears that in 1852, 217 persons were killed, and 486 injured on the railways in the United Kingdom out of a gross total of 89,135,729 passengers; of these persons 181 were killed and 413 were injured in England; 24 were killed and 71 injured in Scotland; and 11 were killed and 2 injured in Ireland. In the year 1853, out of a gross total of 102,286,660 passengers conveyed by the railways of the United Kingdom, 305 were killed and 449 injured; of these, 243 were killed and 369 injured in England; 37 were killed and 68 injured in Scotland; and 25 were killed and 12 injured in Ireland.

## CONDITION OF THE THAMES MARSHES.

*Analysis of the Evidence given before the Select Committee appointed by the House of Commons to inquire into the Sanitary and Agricultural State of the Marshes on the Sides of the Thames, the Means for their Improvement, the existing Legal Powers for the Purpose, and the Necessity for further Legislation thereon.*

Peter Bossey, Fellow of the College of Surgeons, a Medical Practitioner residing at Woolwich, and in practice there for 30 years.—The town of Woolwich is situated on the south side of the Thames, on a little projecting spur from Shooter's-hill, and is bordered on either side by marshes; on the west side by a small amount of marsh, the Charlton marshes, between Woolwich and Greenwich; on the east side by a larger tract, and on the opposite side of the river by the Essex marshes. The town is divided into the eastern district and the western district; it is so divided by the registrar. The eastern district is exposed to the malaria of the marshes, the western district is nearly exempt from it. The marshes on the east form a considerable tract bordering the river; the general impression is that they are about four miles in length between Woolwich and Erith, and varying in breadth from three-quarters of a mile to a mile and a-half between the hills and the river. They are occasionally flooded, which is generally followed by malaria when the water has evaporated, and especially in the autumn and winter of the year. In the spring and summer the evaporation goes on. But there are several sources of this wet condition. The first is the leakage or infiltration from the river itself; the marshes are below the level of the river in that district; consequently there is a leakage through or under the banks. This is evident by what is observed in superficial wells, which are sunk in the marshes for some distance inland; the water in some of these wells will rise and fall according to the ebb and flow of the tide. The amount of this rise and fall in a well recently sunk in the Royal Arsenal, at 250 yards from the river, has been determined by Mr. Senday, the clerk of the works, to be 2 ft. 2 in. every tide, and 2 inches more during the spring tides. Another source of the moisture of the marshes is the land springs, which are particularly abundant. The drainage of these marshes is defective; has seen lately an accumulation of rank and decaying vegetation being cleansed from the ditches. There is unquestionably a greater amount of fever and ague in Woolwich and its neighbourhood than in Chatham. It is difficult to acquire a knowledge of the exact degree of their prevalence beyond one's own observation, but is confident that in Woolwich and its neighbourhood, owing to the wetness of the marshes and their deficient drainage, by the accumulation of rank and decaying vegetation, there is a malaria produced, and there is an excess of moisture which is also detrimental to health. The population of Woolwich, according to the census of 1851, was 32,069. Attributes the large amount of sickness at Woolwich to the malaria which arises from the marshes above East Woolwich. There is no question that this might be prevented by a more efficient system of drainage. Illness increases in the spring when the malaria arises from the water going off and the land drying. Any scheme which would drain the marshes quicker would shorten the period when the malaria is increasing, and prevent the deposit of decaying vegetation. Is confident effective drainage would lessen the amount of disease. Remembered seeing last winter the marshes opposite the Thames under water for a very considerable tract; the marshes on the south side were in places covered. The south or Kent side is not generally flooded, for the reason that it is a sandy loam; the marshes consist of loam on the surface, then there is sand overlying the chalk. The Woolwich marshes are flooded by the upland water coming down. The leakage through or beneath the banks offers an impediment to the running away of the water which comes down from above; it keeps the land in a wet condition, and so obliges the water to flow over the surface or into the ditches. Has heard that formerly the water of the Thames occasionally flowed over the sea-wall and through the banks. The storm waters are dammed back by the embankment. Believes that there is but one sluice so low in the marsh wall that the water can run away at any other time than at low tide; they are only partially flooded on the Woolwich side; if they are not covered, probably the ditches are full, and the land is wet. On the other side has seen it flooded, but it is not the ordinary condition of the marshes. The malaria exercises an influence over a very large extent; has seen ague and remittent fever in the hills as well as in the valleys as far as Woolwich-common and Shooter's-hill; knows that it prevails even beyond those places; the registrar's return shows that it influences London. Malaria varies in intensity; it is, perhaps, most intense in the morning and in the summer season, after there has been a great evaporation going on under a hot sun. In the early mornings, at 3 or 4 o'clock, a little fog arises upon the marsh, perhaps not above 3 ft. high, which is exceedingly offensive upon going into it; has taken a very severe remittent fever and ague from passing through that fog; persons who are out early in the morning in the marshes, before the fog is dissipated, suffer very much from ague, whilst others who live upon the hill and are above the fog, suffer considerably less. Fog does not occur when there is a large quantity of water upon the land, but generally in the summer, when there is least. The peculiarity in the marsh, which had given rise or added a good deal to the epidemics of 1845-6-7, was this: the owners of the marshes, or the persons who used them, had dammed up many of the ditches, so that they were for a long time in a very unclean state; this was followed by a very great extension of ague and intermittent fever. Some horses had been affected with the staggers, and it was supposed to have been produced by their drinking salt water; some of the sluices in the marsh banks are so high that they only admit the water at half-tide, consequently it comes in in a very brackish state. The graziers, to avoid this, increased the number of pens in the marshes, and kept the upland water, so that the cattle could drink nothing but fresh water. Does not know if this damming up exists now. The sanitary condition of Woolwich of late years has rather degenerated. There has been an increase of fever, and also an increase of ague.

James Stewart.—Resides on Woolwich-common; was, until lately, Inspector-General of the Ordnance Medical Department, and has had many years' experience as to the sanitary condition of Woolwich. The night-guard at the Arsenal is especially unhealthy, in consequence of the malaria from the marshes; the malaria is clearly the cause of the fever and ague so locally prevalent; the higher parts of the town are not so unhealthy as the lower parts; there is greater prevalence of ague when the wind is from the north or north-east, that is, when blowing from the marshes; and also when the weather is very hot. Considerable improvement may be anticipated in the health of Woolwich by an effective drainage of the marshes. There is now more arable land than formerly, and consequently more drainage. It is supposed that malarious air is very dense; there is no test for malaria, either mechanical or chemical. Generally a fog is perceived lying over malarious land; there is a kind of haze that falls over the land, and when the sun touches it it rises; that is from the effects of the sun. Thinks it can be proved almost, from what is known of certain localities, that malaria will be carried up the slope of a hill by a light wind; it is never known to descend again from the crest of the hill. Accounts in this way for the agues which happen on Sandy-hill and Plumstead-common. If you take a certain height the land is entirely exempt; still the malaria will travel up a slope. The increase of buildings on the low and unhealthy ground near Plumstead tends to increase the mortality in East Woolwich. There is greater prevalence of ague when a hot summer follows a wet winter. There is liability to remittent fever even if the marshes were very dry.

George Farr, Surgeon in the Ordnance Medical Department at Woolwich.—Has been abroad till lately since 1846; previously passed ten years at Woolwich. Amongst the artillerymen admitted into the hospital at Woolwich, there is a great deal of intermittent fever, and some remittent fever, the former in the spring of the year and the latter towards autumn; the predisposing cause, no doubt, is the malaria of the neighbourhood; diarrhœa arises from the same cause; rheumatism and tic doloreux are also common. The place he conceives to have the greatest proportion of attacks of diseases incident to malaria, next to Woolwich, is about the lakes of Canada. There it was more violent, a more swiftly progressing disease, a remittent fever very frequently terminating fatally in twenty hours. A great many men died of ague during the construction of the Rideau canal.

Rev. William Acworth, Vicar of Plumstead.—The poor children do not attend school in consequence of the prevalence of ague among themselves and their parents, and the expenses consequent thereon. Was compelled to remove from the Vicarage, which was in the marshes, to higher ground, which is perfectly healthy.

William Dickson, Farmer and Land Agent at East Wyckham, near Welling, Kent.—Holds sixty-two acres of marsh land, part under the plough, part under grass. The water is penned up too high sometimes; even now the water is going back in the furrows on the meadow land. There is no drainage upon his land, because there is no outfall. The damage to a crop of wheat per acre, taking it at the lowest, is a quarter of wheat per acre per annum. Calculates the loss with respect to the quantity of hay is upon the average from one-half to three-quarters of a load per acre; a load contains 18 cwt. There is a deterioration of 1*l.* and even 2*l.* a load. Grows upon the upland a-quarter to the acre more wheat on the average than on the marsh land; is satisfied that he could get five quarters to the acre upon the marsh land if it were laid dry. The staple of the marsh lands is not all the same; the land of the lower level next to Erith is of a thinner nature. There was not so much deposit left by the river, because it lies near to the tidal stream, which when receding carried with it the deposit. The marshes do not want lime as a manure; there is lime in the river, from washing the chalk cliffs about Gravesend, which is carried up by the tide, and mixed with the London manure that flows down, and is deposited upon the mud, from whence it finds its way to the marshes. It is a deposit of carbonate of lime, which is next to lime. Has no doubt, speaking as a practical agriculturist, that his marsh land would pay for draining; the obstacles to its being drained are, a great many persons occupying marsh land are graziers, and they like to see plenty of water, as the cowkeepers say the cows will not give milk without they have plenty of water to drink, therefore they pen it to make a head; their land would be the better for drainage, but they are prejudiced. The obstacles, in point of fact, to the drainage of this land, which would be a benefit, not only in an agricultural point of view, but as regards health, are the prejudices of a number of people, who take a mistaken view of the results of draining. With reference to the application of lime, it is well known that it is of no use to apply lime to wet land; but supposing the land were well drained, the farmers would apply lime to it, and therefore increase the value of the land for growing purposes. Suffered last year in making hay, from the water coming back upon the meadow land. His workmen live in the uplands; they will not stop all night in the marshes. Does not keep sheep upon the marshes; is afraid of the rot; they are usually sent in the spring and summer and latter end of the year; they feed there as long as the ground is dry, and when the wet comes on they are removed. It would be possible to provide a supply of fresh water for the stock and cattle in the marshes if they were properly drained; before the South-Eastern Railway carried their conduits under the railway, the managing man of the commissioners did not look sufficiently to one of the conduits under the railway, where the main sewer is, and the banks of that sewer have been made for several years, by the accumulation of the drift from the uplands caused by the fresh water coming in; they have allowed that increase to sink down into solid ground, and now the water rides level with the top of his ground, and the banks being of a sandy and porous nature the water gets into his fields. The cattle could get plenty of fresh water to drink even if the marshes were made thoroughly dry, because the conduits to the river have only to be enlarged, and the mains deepened, to fill the ditches with water, and then deepen the approaches to the drinking places. It is only required to deepen the ponds, and a supply of fresh water can be had; the water should be lowered down so that a drain 3½ feet deep could be made. There is not any force in the objection which is made by the owners of the milch cows, that they will not get plenty of water; they will get plenty of water, only they want it dammed up to the top that it may make a fence. The lowering the water in the marshes by a drain 3½ feet deep would cause an increase in the temperature of the ground; better crops could be had, and water always had by having deeper ditches or larger approaches to that water. On his land there is 6 feet of what is called marsh deposits from the river, upon a bed of peat; chalk is below the peat, it crops out in the uplands. Does not think peat water so good as fresh water. If the ditches were deepened, that would be sufficient. The mud covers the peat; the water does not get to the peat; it forms a nasty drain over it, which is very prejudicial in the spring and autumn. The average rent of land in the marshes is 30*s.* to 40*s.* and 50*s.* an acre; generally there is more given for grass than for arable land; in some places, where it is accommodation land, 60*s.* has been given by butchers. Supposing 30*s.* an acre was now paid for cultivated land, the increased rent, if the land were laid thoroughly dry, would be 5*s.* to 10*s.* an acre. In his opinion there is no want of outfall and no physical difficulty in the way of draining the marshes; plenty of outfall could be got if the sluices were only increased in size and the mains deepened; it does not require any large engineering work. He would rather give 50*s* for an acre well drained than 2*l.* for the undrained. Does not conceive that it would be possible, under present arrangements, to obtain the consent of the necessary number to drain the marshes; it would require an act of parliament. The cost of cultivation on the drained is much the same as on the undrained, except that you pay a little more and have a better crop. The great object of the persons who hold this land in not wishing to have it drained, is to have the ditches as a fence. If those ditches were made deep, they would serve as fences just as they do now; it wants the water to be lower in the ditches, and then you can deepen the drains; the ditches would be just as effectual for fences after they were drained as before; the ponds and approaches must be made deeper where the cattle drink.

William Stockley, Senior Veterinary Surgeon of the Ordnance.—Has been sixty years in the service. When young horses are exposed to marshy, wet situations, there is a peculiar disease generated which arises from the damp and from the impurity of the low marsh lands, which is a disease of the chest and produces water; it is a disease of the pleura; instead of its going on to inflammation it goes on to produce water in the chest. We remove them generally in time, but we never return those who are affected by the marshes. They recover upon the high ground where the Infirmary is situated, and become strong again if they are detected in time. There is precisely the same effect produced in all situations of that kind. No doubt the malaria is debilitating to their constitution; it runs on from inflammation, which is produced by damp, to debility and water; there is nothing peculiar in these marshes to any others which he has seen. When the land has become dry and the air is light, there is no disease among the horses; we keep them in sheds during the winter, and when they are turned out the weather has become warm.

J. Flint South, Surgeon at St. Thomas's Hospital.—Resides at Blackheath-park. His knowledge of the marshes originated in having been appointed last year a member of the sanitary committee of Charlton, and the Walscot district of that parish having been assigned to him, with some others, to overlook. He then made a report to the sanitary Board, of which the following is the substance:—The Charlton marshes are very much lower than the river, from which they are protected by an artificial bank about 10 or 12 feet high. One or two large spring ditches run through them, carrying off the spring water, and also the drainage, from the private ditches; but for the most part the private ditches are very imperfectly looked after. In the river bank are one or two sluices in connection with the spring ditches, which are opened at very irregular times, as may suit the occupiers of the land in their immediate neighbourhood; and consequently, during the greater part of the year, the ditches are in a very filthy, nasty state, very offensive, and full of decayed vegetable matter and mud. The drainage generally is extremely imperfect. Between a private road which separates Charlton parish from Greenwich parish, one part, the eastward side being in Charlton, in the occupation of Mr. Roberts, and the westward side being Mr. Angerstein's property—between that road and Woolwich parish, which is separated from Charlton by a road called the Manor-way, almost the whole of the land is swampy. Even at a very short distance from the surface, if a trench only 12 or 18 inches is dug, it soon fills, and the drainage does not run away. A vast number of houses have been built, and are still building, particularly towards the east end of the marsh, which is in a very swampy, unhealthy condition; many of the tenants state that they cannot keep their ground floors dry, and not even the hearthstones, in some instances. The only drainage from those houses, at the time when he visited them last autumn with other members of the sanitary committee, were some small drains about 18 inches wide, and about as many deep, into which the drainage from the cesspools and from the houses ran; part got away as it could, by soaking into the ground and by evaporation. Where it could not get away quite so quickly, it spread over a large space, and formed very stinking, standing pools of water. Running into these a great number of 6-inch drain pipes are also laid. He went over the district that morning, on purpose to see if any alteration had been made. Is informed, that under the direction of the surveyor of Roupell's estate, to which the greater part of this property belongs, large 12-inch pipes are now being put down, and run into the spring ditches belonging to the Commissioners (although without the right, he believes, to do so), in place of the narrow gutters which were mentioned above as being so offensive; and communicating with them are small pipe-drains for the house sewage, and each two houses having one small pipe drain. It will make the ditches sewers. Thinks the sluice by Charlton pier is regularly opened, but believes the sluice which is by Mr. Angerstein's property, just to the westward of Charlton parish, is raised or put down as it may suit the purpose of the farmers occupying the land.

Sir Culling Eardley, Bart.—Resides at Belvidere, close to the Erith marshes. The neighbourhood of the marshes is in a continual state of ague, which deters persons from settling in the vicinity. It is impossible for the district commissioners of sewers to move in the matter, as it is necessary, but impracticable, to obtain the consent of three-fourths of the proprietors or occupiers in order to carry out a system of drainage. Has been for a good many years a commissioner of the North Level of the Bedford Level, and there is a very striking contrast between the thorough drainage of that district, a long way from the metropolis, and the very defective drainage of our district, which is close upon the metropolis. It has been stated that London stands upon about 20,000 acres of land. Upon the north-east there abuts the Thames marsh district of 32,000 acres of undrained land; this is equivalent to a person living in a house of 20 feet frontage, with a marsh of 32 feet abutting upon it. In the North Level the drainage has been thoroughly effected, by means of applications which might be very easily adopted in this district. The Bedford Level is drained by natural outfall; but the great means which has rendered that district well drained is, that a certain number of persons were chosen by the proprietors who possess their confidence; they have no difficulty in taxing the country, they have very large powers of taxation. Both steam and windmills are entirely superseded. The river Nene has been deepened down to the sea, and by that means a completely natural system of drainage has been obtained. In the Nene the waters flow off only at low water; there are sluices which open at high and shut at low water; but engineers report that the Thames marshes might be drained in the same manner.

Charles John Pinchin, Surgeon in practice at Gravesend.—Bears testimony to the prevalence of ague and severe marsh fevers in and around Gravesend.

James Russell, Farmer.—Had a large farm in the parish of Plumstead; at his own expense under-drained about 200 acres, and found a considerable benefit by it. Thinks all the land in the parish requires under-draining in the marshes. Finds his crops very much improved since he under-drained the land. Has no doubt all the land in the marshes is equal to his, and that they would benefit equally if they were under-drained. The average expense of draining the 200 acres was about 5*l.* or 5*l.* 10*s.* an acre.

David Corbet, M.D., residing at Orsett, in Essex.—The whole type of disease which prevails in his district indicates a malarious and badly-drained country. The influence of the malaria extends a considerable distance; has known it extend as high as Laindon Hills, the name of a parish standing off the marshes and very high.

Richard Heath, Surgeon, Grays.—Fevers and agues are the prevailing diseases in his district; in drained marshes cases of ague are rarely heard of. Questions if any system of drainage would remove the fogs, because fogs occur where there are no marsh lands.

John Manley, M.D., Barking.—The health of Barking has improved considerably within the last fifteen or eighteen years; accounts for this change by the great improvement which has taken place in the drainage of the Barking marshes. It has been brought about by having additional sluices put down, by which means the water is carried off; the ditches are not full, and the ground itself is better drained; it is not swampy.

John Haywood, Clerk to the Commissioners of Sewers for the limits extending from Lombard's-wall to Gravesend-bridge.—The date of the commission is June 30th 1853, being a renewal of commissions which have existed 200 or 300 years; the first was established under 23 Henry VIII. It issues from Chancery, and is directed to persons named by the lord chancellor and chief justice; there are ninety-five commissioners at present; it is an unpaid commission. The tax for drainage works is levied on the occupier, who may or may not claim it from the proprietor. The Commissioners are obliged to charge to each year the expenditure which may take place. The consent of three-fourths of the owners and occupiers is necessary, in order to raise money to be distributed over a period of fourteen years. The tax is always raised by scot, payable in the year. It is highly expedient, for the sake of justice to all parties, and for the improvement of the land, that there should be power to undertake the necessary drainage works, to raise a large sum at once, and to extend its payment by the occupiers, &c. over a period of years. No new works of any kind can be undertaken without consent. The power of occupiers to dam up the water in the private ditches, and the inability of the commissioners to interfere, is productive of very injurious effects. It would be expedient to grant similar powers to the Sewers Commissioners, as were given to the Inclosure Commissioners; if the commissioners were empowered to do new works, unless three-fourths or any stated number objected after notice which might be prescribed, that would probably very materially do away with the difficulties. Upon the survey each year, the commissioners are attended by their surveyor (who is a paid, permanent officer), by the clerk, and by the expenditor; they then inspect the work which has been done during the previous year, and the expenditor produces to them, as they go along, an estimate of the work required for the forthcoming year; the material outlay is for the repair of the Thames embankment. Every year after the survey is made, the commissioners hold an annual meeting, at which they pass the previous year's accounts of the whole of the levels, and any one may attend if he thinks proper. They then make an estimate of the cost for the forthcoming year, and direct the warrants for the levying of scots to be prepared; and then, at a subsequent meeting, the warrants are issued. The books are open for the inspection of any landowner or occupier. The commissioners can levy what amount they please when the works are consented to. The great number of occupiers is the main difficulty to the consents being obtained.

Entirely concurs with the views of Mr. Easton, as given in his report. There is no private act with reference to these marshes; the commissioners work entirely under the public act commonly termed "Hodges' Act." One of the points of this act was to give the commissioners additional powers, with the consent of three-fourths of the owners and occupiers. Before that time the commissioners could do no new works whatever. Then came "Hodges' Act, which said, "You shall have power to do new works, but we will give a controlling power to the owners and occupiers to the extent of three-fourths of the value." Every sluice has a flap to it, which is a self-acting flap, and the outlet is cleansed and discharged by itself, upon the subsidence of every tide; no salt water, throughout the whole of the levels, is admitted. The surveyor is the man to whom, in the first instance, these flaps are entrusted, and then he has under him two or three other persons whose duty it is to see daily to the sluices. The surveyor is paid a stated salary of 100*l.* a-year; it occupies the whole of his time. There is not any power in the commissioners when they see the private ditches in a dangerous state, to compel the owners to repair them; such a provision would be advantageous. In one of the levels, the Stone Great Level, which is a small level, the commissioners having the consent of three-fourths of the owners and occupiers, put down a new sluice at a lower level, and the benefit throughout the whole of that level since has been found very great. Objects to the commissioners being elected by the owners and occupiers.

Robert Westley Hall Dare, a Landed Proprietor in the parishes of Rainham and Wennington, also a Commissioner of Sewers for the district.—His experience of the agricultural state of the marshes is, that drainage is exceedingly wanting; not only these marshes, but the lands both east and west, as far as Barking and as far as Grays. A great portion of the lands between Rainham and Barking are under arable cultivation. Has often known a crop of potatoes to be twice planted and twice flooded in a year. Within the last three years has also known the same accident to happen to crops of wheat; yet, in spite of that, the produce of everything that has not perished by the water is of the most magnificent description; it is land which is capable of growing wheat and potatoes (if the disease does not take them) alternately, without intermission and without manure, for any number of years. Has observed that there are a great many old intersecting walls and high places which have been formed at different levels by the deposit of the river. In all cases in which the level is higher, the grass is finer and of a more fattening quality; in many cases those high places are as much as eight feet above the level of the water. He feels justified, therefore, in concluding that if the waters were reduced over the whole levels to a proportionate depth below the general surface, the quality of all the grass would come to the same pitch as it now is upon those isolated spots.

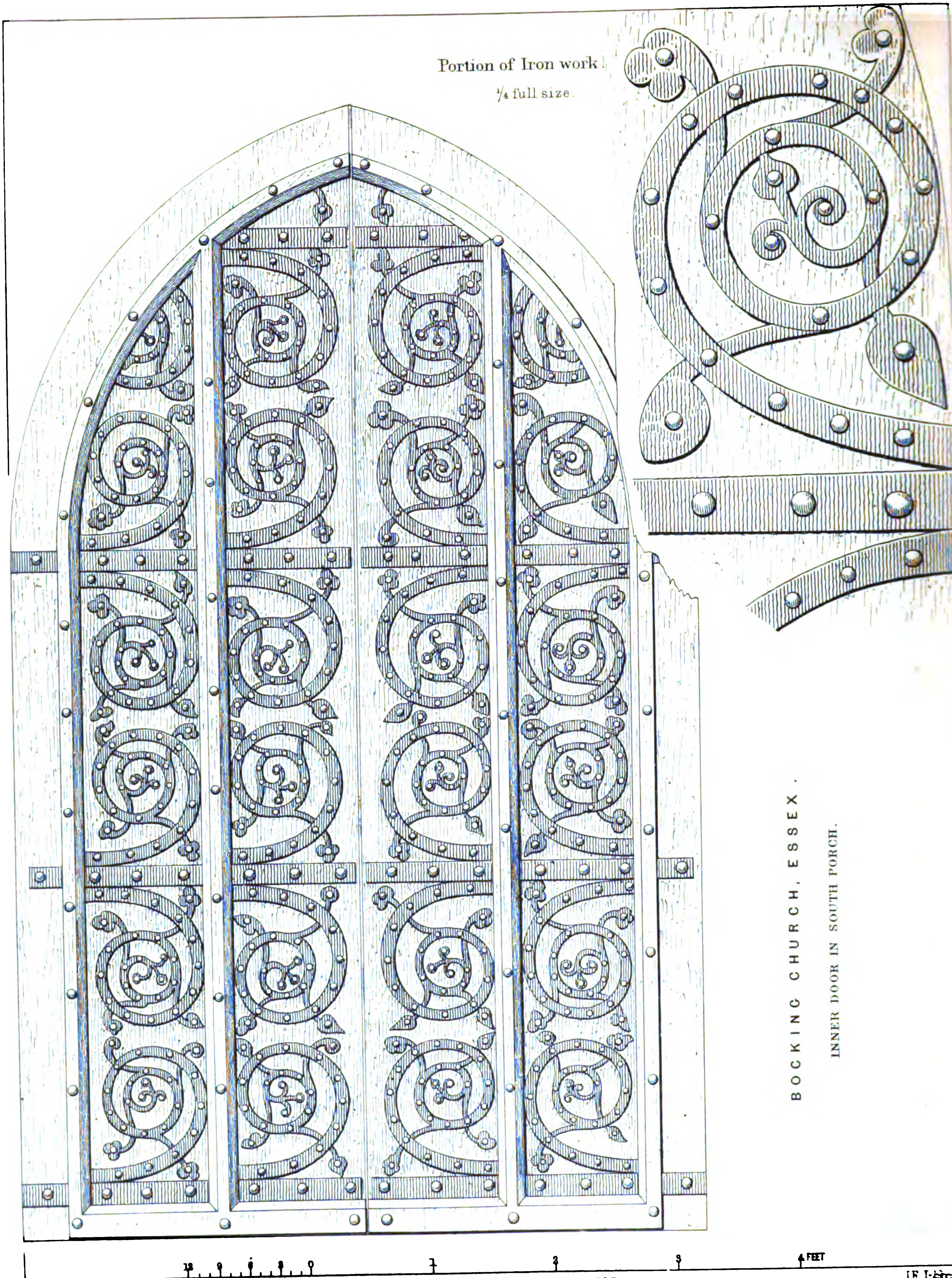
Samuel Westwood, Occupier of Land at Laindon-Hill.—Is a commissioner of sewers on the level beginning at West Thurrock, just below Purfleet, and from thence down to Fobbing. In the level of Fobbing about one-fifth is in arable culture, the remainder in grass; on the level of Mucking to Tilbury, about a-fourth is arable; and in another level, Chadwell to Grays, a-fourth. They are very indifferently drained. A marsh bailiff is appointed to inspect the works, at a salary of 150*l.* a-year. Suggests the appointment of a paid commissioner in each district. Thinks a Board in London would not do at all; in cases of breach, where there is a great extent of water pressing upon heavy walling, it requires somebody upon the spot.

John Ayrton Paris, M.D., President of the College of Physicians.—Bears testimony to the existence of ague in the Eastern part of London as attributable to the influence of the Thames marshes.

W. W. Gull, M.D.—From Woolwich along the line of the Thames, even up beyond Westminster, we are frequently receiving cases of distinct ague and other direct effects of miasm at Guy's Hospital, both into the house and as out patients; about half come from Woolwich and Erith, and the other cases we get from the Isle of Dogs, Greenwich, Deptford, Rotherhithe, Wapping, Shadwell, Bethnal-green, and Whitechapel; we get them along the Thames from Bermondsey and Lambeth, and even from the place upon which these Houses are standing; from Westminster we have marked cases of miasmatic influence. The marsh is one of the most fruitful sources of miasm; has no doubt that London, on the banks of the Thames, is miasmatic. There is no doubt, taking the whole of the population of London, that the draining has had very much to do with lessening the miasmatic condition of London of late years. We however, even now see miasm not only producing ague, but having a distinct influence upon other diseases. The common fever of London in certain seasons assumes, to use our language, quite a miasmatic type. We find persons suffering under typhus and typhoid fevers suddenly losing the characteristics of the fever, and assuming quite an aguish character; cannot say that it has increased of late; it is uncertain in its appearance; we have it in some seasons, and we lose it in others. An effectual drainage of the marshes would remove a fertile source of malaria. The large amount of mud on the banks of the Thames has an injurious effect upon health; for a large portion of the twenty-four hours it is left exposed to the air, when it must be evaporating noxious gases. Marsh miasms are conveyed, no doubt, a considerable distance; sufficiently authentic cases are recorded to show that the influence of marsh miasm extends several miles. Dr. John Macculloch, who wrote a very careful work upon the subject of miasm, gives several instances of its conveyance to that distance; but as the metropolis itself is miasmatic, it would be difficult to separate the effects of the two sources of influence. During this week I find in one of the journals a paper stating that many cases of ague have during this spring been admitted into St. George's Hospital, which the writer supposes may have come from Brompton or Chelsea.

Thomas Webster Rammell, C.E.—Has been directed by the Board of Health to examine the marshes. Has examined the marsh lands generally on both sides of the river. The gross extent of marsh land between London and Sheerness, on the north side, is about 22,000 acres; and on the south side rather more than 16,000 acres; being a total of nearly 39,000 acres. The marshes are divided into separate areas by the high lands which come down to the river Commencing on the north side, the first area of marsh land is the Isle of Dogs, which contains about 400 acres. There is then a very extensive area extending from Blackwall down to Purfleet, where the high land touches the river: that I have calculated in three separate areas, of 2900 acres, 2400, and 2000; making altogether about 7000 acres in that level. There is then on the north side, an area between Purfleet and Grays containing nearly 1000 acres. Then there is, between Grays and Tilbury, an area of about 3000 acres. These areas have been roughly measured from the Ordnance map. Under the Metropolitan Commission are the Isle of Dogs and part of Greenwich marsh, making together about 580 acres. There is then a commission extending over Dagenham, on the north side of the river; that appears to extend from Blackwall down to Rainham, and contains about 5500 acres. Then there is a commission with about 6500 acres, on the north side, between Rainham and a point beyond East Tilbury, just opposite Hope Point. There is then a portion on the north side, near Fobbing, containing about 3300 acres, and which is under a separate commission. Then there is Canvey Island, which appears to be under a separate commission; it contains about 4000 acres. Then there seem to be about 3000 acres of land out of commission on the north side. On the south side, from the Isle of Grain up to Gravesend, there are about 11,000 acres in commission. The extent of marsh land below Gravesend, down to Sheerness, is about 11,000 acres. —The witness was requested by the chairman to state particularly, with regard to the Erith and Plumstead levels, what works are required to carry out a more efficient system of drainage. He said, that area he would take to be 3000 acres of land, about half of which is under arable cultivation, the other half being meadow and pasture. This level is under a commission, extending from Lombard's-wall to Northfleet; the whole of that area is below the high-water level of neap tides; Lombard's-wall is the boundary between the district of the Metropolitan Sewers Commission and the commission alluded to. The lowest parts of that area are about 7 ft. 6 in. above the low water of neap tides; some parts of that level rise as much as 10 feet above the low water of neap tides. A neap tide on the 4th July last rose 14 feet. An ordinary spring tide will rise 18 ft. 6 in. The Plumstead and Erith level is subdivided into fields by ditches, which serve the double purpose of fences and of reservoirs for supplying water to the cattle. The total length of ditch upon the area is about 84½ miles, which, at an average width of 6 feet for each ditch, will give about 60 acres of land. Found the level of the water in the ditches to be generally such as not to admit of subsoil drainage; should take 3 ft. 6 in. to 4 feet as the depth of subsoil drainage. The area is at present drained by five sluices, which are at levels respectively of 3 ft. 6 in., 3 feet, 3 ft. 6 in., and 2 feet above the level of neap tides. The best mode of improving this district would be to get rid, as far as possible, of the stagnant water in the ditches. The five sluices close by ordinary wooden flaps at the rising of the tide; one is of cast-iron; they are self-acting. Proposes to subdivide the land, so as to prevent the stock from the grass land getting into the arable land, by using the ditch partly as a fence, and planting quick on one side, with a line of posts and rails to protect it. The abolition of the ditches involves the question of water supply to the cattle, as well as of fencing. Twenty miles of the ditches might be abolished; the remaining 64½ miles might be laid dry, and a hedge fence added to them. Would partially fill up the abolished ditches, sloping the ground on either side; there would be a clear gain in the value of the land obtained, after the works are completed. Witness then described the works he proposed for the drainage of the marshes. He divided them, first, into main works of drainage; secondly, into works of water supply for the cattle; thirdly, into works of fencing; and fourthly, works of subsoil drainage. The main works which he proposed would cost about 8000*l.*; they would consist of a main cut through the centre of the level, with other cuts leading to five outfall sluices, those sluices being placed at a level of 2 feet above low water of neap tides. The works would be laid out in give-and-take lines; in some cases there might be a positive interchange of land; it would be necessary to have some power of changing. Would make the cuts five yards wide; and then, for ensuring a change of water in the main cut in dry weather, proposes to fix three inlet sluices, the cost being included in the estimate of 8000*l.* The water supply for the cattle would be best obtained by storage reservoirs at the foot of the high lands adjoining the marshes, and conveyed to the separate fields in iron pipes; the cost of these works he estimates at 3900*l.* The cost of the fencing he puts down at 8400*l.*; proposes to have quick planted on one side of the ditch, protected for the time by a three-railed post and rail fence; has estimated that at the rate at which fences on the side of railways have been done. The subsoil draining of 3000 acres is taken at 16,500*l.* or 5*l.* 10*s.* an acre; proposes to do it from 3 ft. 6 in. to 4 feet deep. Considers that a two-inch pipe would be sufficient; would lay the lines about eight yards apart. Has taken 1*d.* a yard for the laying, and 1*d.* a yard for the pipe; the whole of the works described would involve a total outlay of 36,800*l.* on those 3000 acres of land; or 12*l.* 4*s.* 10*d.* per acre. The outlay per acre on the main works will be 2*l.* 13*s.* 2*d.*; on those for the supply of water, 1*l.* 5*s.* 8*d.*; the fences will cost 2*l.* 16*s.*, and subsoil drainage 5*l.* 10*s.* Supposing the money to be borrowed at 4 per cent., and to be paid off by equal annual instalments of principal and interest in thirty years, it would require 3*s.* 1*d.* per acre per annum for the main works; for the water supply 1*s.* 7*d.*; for the fences 3*s.* 4*d.*, for the subsoil drainage 6*s.* 5*d.*; making a total of 14*s.* 5*d.* per acre per annum. Imagines that the annual expense of keeping up this fencing, clearing the quick, and so on, would not exceed the present annual expenses of keeping up the fences properly, as the one would balance the other; did not receive the instructions to inquire into this matter more than ten days ago; is not prepared to give evidence on minor points. Does not calculate in the 3*s.* 4*d.* the annual expense of keeping up the fences; the 3*s.* 4*d.* represents the annual instalment per acre for that item, spread over thirty years. Supposes the posts and rails would last about ten years, and by that time the quick will be sufficiently strong to serve as a fence. Proposes emptying the ditches of water. Has thought of the plan of deepening those ditches, and retaining them as fences; but no material improvement in the health of the district would take place unless the water be got rid of; the mere lowering of the ditches would not improve the health of the district. Does not know how a circulation of water is to be got through the ditches; and unless there is a change of water, does not see how there is to be an improvement. Thinks the diseases which are incident to low situations are not affected by the mud which is on the outside of the wall; the malaria is chiefly due to the stagnant water in the marshes; either water held up in the soil itself, or contained in the ditches. The outlet sluices will be of cast-iron, the drain pipes of earthenware. Has made no calculation on the subject of the improved value of the land after these works are completed; it is rather an agricultural question than an engineering one. It would not be necessary if these ditches were deepened to any extent to have them walled up with stone; the deepening would not be more than nine inches or a foot; most of them are now some 4 or 5 feet deep. Thinks no material improvement would take place unless the present stagnant water be removed; conceives the works he proposes are not larger than would be necessary for that purpose. The opening of the private ditches would not keep the water flowing; by so doing the level of the stagnant water is simply lowered, not removed; for many months of the year there is no water going down those ditches. Perhaps the subsoil drainage might not be considered a necessary work, but with that exception considers the works are necessary works; the subsoil drainage is very nearly half the amount. The value of this marsh land is about 60*l.* an acre; these works would cost a fifth part of their value. With regard to the subdivision of these fields, his idea would be to throw them all together, and have the power for an exchange of land of the different owners. The proposed division, taking into account the abolished ditches, would lay the land into about 20-acre fields over the whole area. Proposes five main sluices, and to fix those at a level of about two feet; practically it will be a perfect level across the marshes; it would contain about one foot of water at the lowest; it will be water which might be changed with the inlet sluices; it will be water admitted from the river. In dry seasons should take in water; but in the winter should not want it, because there would be sufficient hill water coming down; his object would be to prevent the water becoming stagnant. The only improvement of which the district is susceptible is getting rid of the stagnant water; he means the stagnant water partly in the soil itself (which could be got rid of by subsoil drainage), but that chiefly in the ditches. Without subsoil drainage, does not consider that the mere fact of getting rid of the stagnant water in the ditches would thoroughly drain the land; it would not have any practical effect upon the stagnant water in the land. The necessary consequence of draining the ditches would be, that there would be no water for the stock; the reservoirs proposed for supplying the stock can be filled by a system of ponds throughout the level; would get the water for the ponds from the subsoil drains. Should propose to construct these reservoirs and make them each capable of holding 500,000 gallons; would lay a system of pipes from the reservoirs, and the whole of these works of water supply would cost about 4000*l.*; The actual cost of supplying water would be nothing; the tanks would be supplied by self-acting ball-cocks. Assumes that the expense of management would not be greater than it now is over the level; it might be slightly increased. Without subsoil drainage the main works might improve the sanitary condition of the district; omitting the subsoil draining would reduce the estimate by 5*l.* 10*s.* an acre. The land would derive a benefit from subsoil drainage to a greater extent than the amount of outlay; assumes that the subsoil drainage would pay for itself.

JAMES EASTON, Civil Engineer.—His attention has been called to the state of the Plumstead and Erith marshes for the last ten or twelve years. The marshes have been greatly improved since 1847, when we lowered some of the ditches and regulated the water supply; but the commissioners had not power to carry out all that he then suggested. His report of 1847 was not only with reference to draining, but as to the repairs of the walls, and putting them into a proper state. The steamboats going up and down the river have so much washed away the underside of the banks, that the stone paving for protecting the banks is washed down more than it used to be. His investigation was with a view of seeing what it would cost to put the walls into a permanent state of repair, and for that purpose the report of 1847 was made. The report of 1853 was more with regard to the draining. After the works that he suggested in 1847 were carried out, in going over the marshes again in 1853, he found that ague had been very much less, from lowering the ditches and not having so much water in them. The ditches were lowered as far as the commissioners had power at that time, and since then the health of the neighbourhood has been very much improved. Has given the commissioners a plan for draining these marshes thoroughly. It is by lowering the present sluices to within a short distance of low-water mark. For instance, the Green Level Sluice could be lowered 3 feet (the bottom of the sluice is 4 feet above low water); the Great Breach Sluice, 6 ft. 2 in.; and the Abbey Level Sluice, 3 ft. 18 in. The Old Corn Marsh was 6 ft. 6 in. and the Crab Tree was 5 ft. 6 in. In arranging this drainage has cut the drains as near as possible to suit the different occupiers and owners, so as not to subdivide the land belonging to any individual. In the intermediate fields the report suggested the filling up of as many ditches as could be. A very considerable quantity could be filled up by enlarging the fields belonging to the same owner, by the




BOCKING CHURCH, ESSEX.

INNER DOOR IN SOUTH PORCH.

J D Wyatt. del

Pub^d by D Bogue. 86 Fleet St. Aug. 1. 1854.

throwing two or more fields into one, and not interfere either with the drinking places for the cattle or the subsoil draining Lowering the water in the ditches would enable the parties to thorough drain. There would be outfall sufficient. Improvement has already resulted from subsoil draining; Mr. Russell has subsoiled many of his fields with very good effect. If the ditches were lowered throughout the whole level, the same improvement would follow; believes the farmers would do it themselves within a few years; but they have not the means, because some of the ditches will not admit of it; but by lowering them altogether it could be accomplished without interfering with the drinking places for the cattle. The difficulty is, a portion of the ditches are not under the command of the commissioners; conceives that to carry out any perfect system of drainage, it would be necessary that the whole of the ditches, those which are called sluices and those which are called cuts, should be under one management. The amount of his estimate of the expense was an outlay of about 30*s*. an acre; that would not include the whole system of thorough drainage, but thinks it would make a complete system of general drainage of the marshes, and would allow of the other being done; the drainage would be effected to such an extent, that the land would be put in such a condition that every farmer could subsoil for himself. The difficulty of draining these lands is the defective nature of the outfalls from the fields into the various ditches; his scheme would remedy that evil. The main outfalls run into the river, and by lowering those an outfall in the other drains is gained. Does not know that there has been any alteration in the bed of the river of late years, so as to account for the fact that the sluices have been made too high; at the time these sluices were put in, thorough draining was not thought of, particularly in that sort of land. The only inconvenience from the sluices being very low is in case of repairs being necessary; there are sluices upon some of the lower levels very nearly level with low-water mark. He would lay the sluices as nearly level as possible, to get a greater fall. The effect of a fall in that distance would not be great, it being only about 100 feet long, although 100 feet is considered a long sluice. The ordinary breadth of the sea-wall at the base where the sluice goes through, varies from 60 to 100 feet; some may be 50 feet. Does not know whether Mr. Rammell has discovered that in the whole of the marshes on the Kentish side there are springs of water issuing from the chalk; and there is an immense quantity in that level, quite enough to spread all over the ditches if it is managed properly; they are main springs out of the chalk; they occur in all the lower levels; they run out in the ditches, and they rise in the ditches, as though they were ordained to feed the cattle. There are not springs always rising in marshes. In the marshes under this commission, there are five or six beautiful springs flowing up. From the want of greater power in the commissioners we have had some difficulty in arranging the water all over the level, for the cattle. The evil arises from the want of a uniform system of drainage throughout the level. If the commissioners had proper powers to carry out a system of drainage, has no doubt it would be done; does not see any engineering difficulties. Thinks the drainage of the marshes would pay commercially; it would pay at his estimate. It would not pay at an estimate of 14*s*. 5*d*. an acre additional rent per annum, without thorough draining; the mere lowering of the sluices would not increase it so much as that, but it would give to the farmers the means of thorough draining. The 14*s*. 5*d*. of which the last witness spoke as the annual expense per acre included thorough drainage. The rental of the land in the marshes varies; including the wall scot, it is about 50*s*.; the wall scot is from 7*s*. to 8*s*.; it is worth about two guineas an acre; the wall scot is deducted. The owners and occupiers are not favourable to a large outlay. In sinking the main ditches below what they are at present, has not made any calculation as to the necessity of making them much broader than they are at the top. The deepening would not be much, except in a few places; where the principal deepening takes place the land is low, and is near the river; there are two or three places in the marsh where the land surface is very near the water surface, and the ditches could be sunk enough to drain the land without inconvenience as to width. There would not be any necessity for walling to keep up the banks, or any additional cost to the proprietors of the lands in maintaining those ditches perfectly clear and in order; has had experience of that from the works which were executed in 1847. In lowering these ditches the subsoil into which we get is clay; there is no wash at all. The total estimate for the works which the commissioners propose to carry out for the portion in the commissioners' hands was about 1670*l*., including the sluices; then, for sinking the private ditches and preparing drinking places for the cattle, he estimated the expense at 1721*l*. Does not think it would do to choose the commissioners generally from the farmers; in most districts you find but few farmers who would be intelligent enough for it; generally speaking, thinks they are jealous of each other, and are afraid of one having more done than another. Should say that a better commission would be chosen from the gentlemen in the neighbourhood, with probably a few of the most intelligent of the farmers.

## REVIEWS.

*Details of Gothic Architecture, Measured and Drawn from Existing Examples.* By JAMES K. COLLING, Architect. London: Bogue. No. 33.

(*With an Engraving, Plate* XXXV.)

During the progress of this work, through the kindness of the proprietors, we have heretofore been enabled to give in our pages several specimen plates, to which we now add another, devoted to a Doorway in Bocking Church, Essex, which may be considered a fine sample of existing ancient scroll iron-work. Besides this, there are five other plates in the number before us, of Early English work, embracing chaste and well-proportioned doorways from Barkby Church, Leicestershire; examples of piers, capitals, and bases, with ornaments from the springing of arches and vaulting shafts from the Churches of Boxgrove and Broadwater, Sussex. The whole of the subjects in this number are well chosen, for reference, as to simplicity of design, and suitableness for adaptation.

As this work is now very rapidly advancing to its completion, it may not be amiss to inform our architectural friends, to whom it may yet be unknown, that it will contain when complete nearly two hundred plates, showing an almost encyclopædic mass of well-selected detail, which must prove of the greatest value in assisting the profession engaged in rearing Gothic structures throughout the country, whether they wish to consult it for exterior or interior construction. By the plates being clearly drawn to a large scale, one great evil has been obviated which attended most of our architectural works; and, we may add, that we believe the entire series of illustrations have been first published in the pages of our author.

*Picturesque Atlas of the Railway over the Sœmmering, Austria.* By CARL GENGA. Vienna: Gerold and Son. 1854.

This truly splendid work is the production of the director of the above-named railway, Carl Genga, knight, who, in 1842, was dispatched to the United States for the purpose of studying the construction of the railways of that country, and who, after his return, projected the plan of the one under notice. This volume contains a number of statistical data on Austrian railways in general, and the Sœmmering line especially, with a series of beautiful drawings of that gigantic and surprising undertaking—placing before the profession and the public the result of each grand and praiseworthy exertion.

*Suggestions for Improvements in the Sewerage of Cities and Towns.* By CHARLES F. MOORE, M.D. Dublin: Hodges and Smith. 1854. pp. 12.

The author of this pamphlet, a member of the medical profession for eighteen years, does not think it advisable to interfere with the long-tried and useful egg-shaped sewers, but suggests that, the present water-closet system in the houses of the upper and middle classes should be retained. Every five, ten, or more houses of such classes to be provided with a filtering and deodorising cistern, divided into compartments furnished with a self-regulating apparatus which would cause a discharge of disinfecting powder, as dry peat powder, powdered gypsum, peat charcoal, coal ashes, lime, or other deodorising solid or fluid, proportioned to the ingress of house sewage,—the latter to be conveyed from each house by earthen pipes properly set in a bed of masonry, or small brick sewers, or other suitable means, and at such an inclination as to insure proper discharge; also each deodorising cistern to be provided with a suitable exit channel for filtered and deodorised fluid to convey the same into main-street sewers. Every such cistern to be placed in a convenient position in a back street, lane, open space, or yard, that it may be daily emptied of all its solid or semi-solid contents, and that it shall be so constructed that its compartments shall permit of this being done without inconvenience or interruption to the house sewage, and so as to permit the removal of its contents by suitable trap-doors or sluices; the whole to be made of flags or strong slate, or other suitable material,—due attention to be paid to position of said cistern as to fall, &c. And it is suggested that persons in the immediate vicinity of such cisterns should have a portion of proceeds of sale of contents under some circumstances. District overseers to keep constant supervision over the state of such cisterns.

In all lodging-houses, hospitals, barracks, poor-houses, and houses of the lower classes, the author would have closets of simple construction, yet such as would insure immediate deodorisation, applicable to both solid and fluid sewage, or either as the case might determine, and either in connection with the general sewage or not (although he would prefer separation of solid and fluid matters for many reasons); the process of deodorisation to be effected by drawing a simple valve or other contrivance whereby a quantity of powdered gypsum, dry powder of peat, peat charcoal, coal ashes, lime, or other deodorising substance, should be discharged upon the matters in such closet. Each closet to be cleaned out thoroughly at least once a day in winter, and twice daily in summer, and contents to be removed in covered wagons or barges, or by railway, and at once sent to the country as manure. As no water should be used in these closets, the bulk of matters to be removed would be very small; and as the closet-pans would be made portable, no difficulty would be experienced in emptying them into wagons.

## ON SILICA AND SOME OF ITS APPLICATIONS TO THE ARTS.[1]

By Rev. J. Barlow, M.A., F.R.S., V.P.R.I.

Silica is one of the most abundant substances known. Quartz, common sand, &c., flint, chalcedony, opal, &c., and a variety of sand described by Mr. J. T. Way,[2] may respectively be taken as examples of crystallised and uncrystallised silica. Under all these forms silica is capable of combining with bases as an acid. Heat is however essentially necessary to effect this combination, a combination of which all the well-known silicates, whether natural, as feldspar, mica, clay, &c., or artificial, as glass, &c., are the results. The common forms of insoluble glass are produced by the union of silica with more than one base. But, when combined with an alkaline base only, silica forms a soluble glass, the degree of solubility of which depends on the proportion which the siliceous acid bears to this alkaline base. This soluble silicated alkali (or water-glass) may be prepared by various processes. If sand be used, 15 parts of fine sand, thoroughly incorporated with 8 parts of carbonate of soda, or with 10 of carbonate of potass and 1 of charcoal fused in a furnace, will produce a silicated alkali which is soluble in boiling water. Messrs. Ransomes obtain this silicated alkali by dissolving broken flints in a solution of caustic alkali at a temperature of 300° Fah.[3] And, more recently, Mr. Way has observed that the sand which he has described will combine with caustic alkali at boiling heat, also producing a water-glass.

This water-glass has been applied to several important purposes, three of which were specially noticed.

I. *To protect building-stones from decay.* The stone surfaces of buildings, by being exposed to the action of the atmosphere, become liable to disintegration from various causes. Moisture is absorbed into their pores. The tendency of their particles to separate, in consequence of expansion and contraction, produced by alternation of temperature, is thus increased. Sulphurous acid is always present in the atmosphere of smoke-burning cities, and cannot but corrode the calcareous and magnesian ingredients of oolites and dolomites. It is true that good stone resists these sources of injury for an indefinite time, but such a material is rarely obtained. As a preventive of destruction, whether arising from physical or chemical causes, it has been proposed to saturate the surfaces of the stones with a solution of the water-glass.

It is well known that the affinity of silica for alkali is so feeble that it may be separated from this base by the weakest acids, even by carbonic acid. According to the expectation of those who recommend the silication of stone, the carbonic acid of the atmosphere will set the silica free from the water-glass, and the silica, thus separated, will be deposited within the pores and around the particles of the stone. The points of contact of these particles will thus be enlarged, and a sort of glazing of insoluble silica will be formed sufficient to protect the stone against the effects of moisture, &c. This cause of protection applies chiefly to sandstones. But wherever carbonate of lime or carbonate of magnesia enters notably into the composition of the building-stone, then an additional chemical action, also protective of the stone, is expected to take place between these carbonates and the water-glass. Kuhlmann[4] remarks "Toutes les fois que l'on met en contact un sel insoluble avec la dissolution d'un sel dont l'acide peut former avec la base du sel insoluble un sel plus insoluble encore, il y a échange; mais le plus souvent cet échange n'est que partiel." In consequence of this "partial exchange" an insoluble salt of lime may be looked for whenever a solution of water-glass is made to act on the carbonate of lime or carbonate of magnesia existing in oolitic or dolomitic building-stones.

This expectation, however, has not been alogether sanctioned by experiment. A gentlemen, eminently conversant with building materials,[5] immersed a piece of Caen stone in a solution of silicate of potass in the month of January 1849. This fragment, together with a portion of the block from which it had been separated, was placed on the roof of a building in order that it might be fully exposed to the action of atmosphere and climate. After four years the silicated and the unsilicated specimens were found to be both in the same condition, both to be equally corroded. These specimens were exhibited in the theatre of the Institution. But whatever ultimate results may ensue from this process, the immediate effects on the stone are remarkable. Two portions of Caen stone were exhibited, one of which had been soaked in a solution of water-glass two months before. The surface of the unsilicated specimen was soft, readily abraded when brushed with water, and its calcareous ingredients dissolved in a weak solution of sulphurous acid. The silicated surface, on the other hand, was perceptibly hard, and resisted the action of water and of dilute acid when similarly applied.[6]

II. Another proposed use of the water-glass is that of *hardening cements, mortars,* &c., so as to render them impermeable by water.

Fourteen years since, Anthon[7] of Prague proposed several applications of the water-glass. Among others he suggested the rendering mortars waterproof. He also suggests that this substance might be beneficially employed as a substitute for size in whitewashing and staining walls. It was demonstrated by several experiments that carbonate of lime mixed up with a weak solution of water-glass and applied as a whitewash to surfaces, was not washed off by sponging with water, and that common whitewash laid on in the usual manner with size, was rendered equally adhesive when washed over with water-glass.

III. *The Stereochrome of Fuchs.*

The formation of an insoluble cement by means of the water-glass, whenever the carbonic acid of the atmosphere acts on this substance, or whenever it is brought in contact with a lime-salt, has been applied by Fuchs to a most important purpose. The stereochrome is essentially the process of fresco secco[8] invested with the capability of receiving and perpetuating works of the highest artistic character, and which may be executed on a vast scale. Fuch's method is as follows[9]:—

"Clean and washed quartz-sand is mixed with the smallest quantity of lime which will enable the plasterer to place it on the wall. The surface is then taken off with an iron scraper in order

[1] Substance of a Lecture delivered at the Royal Institution of Great Britain, April 7, 1854.

[2] Quarterly Journal of Chemical Society, July 1, 1853, and Journal of Royal Agricultural Society, Vol. XIV. p. 1.

[3] Report of a communication made to the Royal Institution by Professor Faraday, May 26, 1848. *Vide* Athenæum, June 17, 1848.

[4] Expériences Chimiques et Agronomiques, p. 120.

[5] Charles H. Smith, Esq., one of the Authors of the "Report on the Selection of Stone for the Building of the New Houses of Parliament."

[6] Silliman's American Journal, January 1854, contains a notice of the application of the water-glass to the decaying surfaces in the Cathedral of Notre Dame in Paris.

[7] Neuere Mittheilungen über die Nutzanwendung des Wasser-glases, 1840. This subject has been fully treated by Kuhlmann in his "Memoire de l'Intervention de la potasse ou de la soude dans la formation des chaux hydrauliques," &c. 1841. Expériences Chimiques et Agronomiques.

[8] Vide Eastlake's Materials for a History of Oil Painting, p. 142.

[9] These particulars were obtained by Dr. Hofmann from Mr. Echter. A stereochromic picture by Echter, and a sample of the water-glass as prepared by Fuchs, were also exhibited by Dr. Hofmann.

to remove the layer formed in contact with the atmosphere, the wall being still moist during this operation. The wall is then allowed to dry; after drying it is just in the state in which it could be rubbed off by the finger. The wall has now to be fixed, *i. e.*, moistened with water-glass.[10] (An important point is not to use too much water-glass in moistening the wall.) This operation is usually performed with a brush. The wall must be left in such a condition as to be capable of receiving colours when afterwards painted on. If, as frequently happens, the wall has been too strongly fixed, the surface has to be removed with pumice and to be fixed again. Being fixed in this manner, the wall is suffered to dry. Before the painter begins he moistens the part on which he purposes to work with distilled water, squirted on by a syringe. He then paints: if he wishes to repaint any part he moistens again. As soon as the picture is finished, it is syringed over with water-glass. After the wall is dry, the syringing is continued as long as a wet sponge can remove any of the colour. An efflorescence of carbonate of soda sometimes appears on the picture soon after its completion. This may be removed, either by syringing with water, or may be left to the action of the atmosphere." Not to dwell on the obvious advantages possessed by the stereochrome over the real fresco, (such as its admitting of being retouched and its dispensing with joinings), it appears that damp and atmospheric influences, notoriously destructive of real fresco, do not injure pictures executed by this process.

[11] The following crucial experiment was made on one of these pictures. It was suspended for twelve months in the open air, under the principal chimney of the New Museum at Berlin; "during that time it was exposed to sunshine," "mist, snow, and rain," and nevertheless "retained its full brilliancy of colour."

The stereochrome has been adopted on a grand scale by Kaulbach, in decorating the interior of the great national edifice at Berlin already alluded to. These decorations are now in progress, and will consist of historical pictures[12] (the dimensions of which are 21 feet in height and 24½ feet in width), single colossal figures, friezes, arabesques, chiaroscuro subjects, &c. On the effect of the three finished pictures, it has been remarked by one whose opinion is entitled to respect, that they have all the brilliancy and vigour of oil paintings, while there is the absence of that dazzling confusion which new oil paintings are apt to present, unless they are viewed in one direction, which the spectator has to seek for.

Mr. A. Church has suggested that if the surface of oolitic stones (such as Caen stone) is found to be protected by the process already described, it might be used, as a natural intonaco, to receive coloured designs, &c., for exterior decorations; the painting would then be cemented to the stone by the action of the water-glass.

Mr. Church has also executed designs of leaves on a sort of terra-cotta, prepared from a variety of Way's silica rock, consisting of 75 parts clay and 25 of soluble silica. This surface, after being hardened by heat, is very well adapted for receiving colours in the first instance, and for retaining them after silication.

## NEW NATIONAL GALLERY.

Sir—I see, with great regret, that it is stated in your publication that the Chancellor of the Exchequer is not pledged to throw the designs for the New National Gallery open to public competition. I am sorry for this, for, whatever the evils of the system as a grievance upon the architects, competitions are productive of public good. Such a work as a New National Gallery would be a stimulus to architectural exertion, and a means, by the exhibition of the drawings, of creating a public interest for architecture. I hope, therefore, we shall have a competition. At all events, I hope the selected plans may be exhibited, and not smuggled as those of the British Museum were attempted to be.

*Gower-street, Sept.* 20, 1854. ARCHITECTUS.

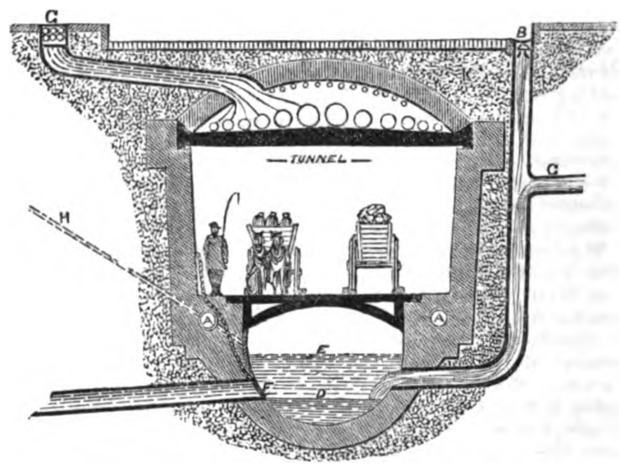
[10] The composition of the specimen produced was—Silica, 23·21 per cent.; Soda, 8·90 per cent.; Potass, 2·52 per cent.; and the specific gravity of the solution was 3·81.

[11] Communication from Mr. George Bunsen.

[12] Three of these pictures are finished, viz. 1. The Fall of Babel; 2. Die Blüthe Griechenlands ('the golden age of Grecian art and poetry'); 3. The Fall of Jerusalem (an engraving of this picture was exhibited by Mr. Ackerman).—Two other compositions are drawn, viz. 4. The Battle of the Huns; 5. The Crusaders' arrival before Jerusalem.—6. This subject not yet decided on.

## AUSTIN'S SUB-WAY.

It is here proposed to provide for all the desiderata required in our main London streets—for drainage, waterage, gasage, electro-wirage, railage, or any other "age" connected therewith. The engraving speaks for itself. A large sewer occupies the lower part, from which overflow pipes run into the river, at intervals, to take off quickly the storm or continued rain water. Mr. William Austin (of Mr. Peto's establishment), the inventor, or projector, proposes to run his large drains from streets, into sewers constructed at a considerable depth on each side of the river (beneath the shores), between high and low water mark; to convey the soil to the extreme parts of London, to be pumped up into reservoirs, for purposes of manure, or discharged into the river below the influence of the tide, beyond Barking Creek. Over the sewer of streets, is a strong, continued stage of iron and wood, upon which runs the railway and tramway, with a footway on each side. Over these are strong iron girders to carry the main pipes for gas, water, &c.; these girders are placed at sufficient distances apart to suit the lengths of the pipes. A strong brick arch spans the whole; the spandrils and crown of arch, filled in with concrete, receives the paving. An "eye" and horizontal shaft is formed through arch to footways, fronting each house, for the service pipes (at regulated distances) to pass on to the supply pipes, laid in an opening trunk running lengthways and level with paths. The electric wires are suspended to the soffit of the arch. The sewer and tunnel is proposed to be ventilated by coke fires and shafts, and iron man-hole traps will be placed at intervals in crown of arch. No effluvia can ascend from the house drains to the streets through gully-holes, as all would be effectually water-trapped.




A, A. Horizontal Flues for collecting foul gases from Sewer.
B. Patent Water-Trap over Gully-hole.
C. House Sewage Pipe.
D. Low Level of Sewage waters.
E. Flood Level of Storm waters.
F. Outflow to River.
G. Supply Pipes.
H. Pipe to Fires for Consuming Foul Gases from Sewers.

This scheme may appear too great for unpractical men, but we see no immediate reason why it cannot be practically carried out, with a saving in the long run; for the constant wear of the pipes underground, and consequent leakage, besides the expensive nuisance of taking up the paving on every occasion of repair, would be avoided, and would soon repay the extra cost. An opportunity now occurs when the experiment might be tried with advantage, if it be true that the new Victoria-street sewer—that "sink-hole of expense"—is to be rebuilt; a sub-way might be formed under Victoria-street, which would be a grand experiment, and could be done there with less annoyance or cost than in any other street in London, and might be given as an example to the authorities in large towns, who are only now beginning to think of draining them. But why suggest so feasible a scheme, when millions are being spent abroad in war, with a right good will, and simple thousands, or even hundreds, begrudged for the benefit of the health and comfort of the people at home?

## STOPPAGE OF CANALS.

The new water-weed, about which a good deal has been said lately, and which has proved so serious an evil wherever it has shown itself, is not the only difficulty that has recently attended the working of canals in this country, a still more alarming hindrance to their traffic being the short supply of the element employed for its conveyance. The Huddersfield Canal, extending from Huddersfield to Ashton-under-Lyne (about twenty miles), where it communicates with the Ashton and Oldham Canals to Manchester, was closed on the 6th inst., in consequence of the supply of water not being sufficient to keep it open for traffic. The Macclesfield Canal, which leaves the Trent and Mersey Canal near the Harecastle tunnel, on the North Staffordshire Railway at the northern end of the Potteries, and extends to Marple, near Stockport, where it joins the Peak Forest Canal, was closed last Thursday from the same cause, and we understand that the Caldon branch of the Trent and Mersey Canal, near Leek, in Staffordshire, has also been closed. The managers of the Rochdale Canal have given notice that vessels navigating that canal are not to draw more than 3 ft. 8 in. of water, and, unless there is a considerable fall of rain, not only this canal, but also the Ashton and Oldham and Peak Forest Canals, leased by the Manchester, Sheffield, and Lincolnshire Railway Company, and the Trent and Mersey Canal, will have to be entirely closed very shortly. The Ashton and Oldham and Peak Forest Canals must have been closed on Monday but for the rain, which has fallen since Saturday night, and the "favourable" weather which prevails in that district gives some hope that an entire stoppage may be averted; but a very considerable additional supply will be required to allow of more than a continually interrupted navigation for some weeks to come. In the district traversed by these canals there was no supply worth mentioning, available for canal purposes, from the time of the melting of the snow in January, till July, when there would have been a suspension of working but for the fall of rain which took place between the 9th and 19th of that month. The Bridgewater Canal, between Manchester and Runcorn, is fortunately situated, for all the canals we have mentioned "lock down" into it and supply it with water, and consequently it may be expected to keep open longest; but the water—always scarce at this season of the year—is now very much reduced, and, as the sewerage of the filthy river Medlock in Manchester drains into it, the absence of any large supply of purer water has caused a most offensive and unhealthy stench to arise from this canal, which is perceptible at a considerable distance from the banks. Unless some effectual steps are taken to remedy this, it will prove very injurious to the district between Manchester and Altrincham, in which, during the last few years, the facilities of railway communication have induced a great influx of out-of-town residents, whose business lies within the city, but who will of course be desirous to escape the dangerous proximity of such a nuisance. This threatened suspension of upwards of 200 miles of canal communication must be a very serious interruption to the traffic of the district which it traverses. On the Ashton and Oldham, Peak Forest, and Macclesfield Canals, 86 miles in all, the average amount conveyed is 25,000 tons per week; upwards of 4000 tons being carried by the Macclesfield Canal, which has been already shut. Some of these canals, although they have been in existence more than half-a-century, have never been known to stop, and certainly none of them have been reduced to that extremity during the last forty years. On the contrary, previously to the opening of the immense reservoirs at Woodhead, the corporation of Manchester were supplied with 200,000,000 gallons, or 2000*l.* to 3000*l.* worth yearly, from the surplus waters of the three canals last-named, which during this year would have had none to spare if it had been required. By these three canals, also, about 2000 tons of lime per week are conveyed from the mountainous districts of Derbyshire to Manchester and the neighbourhood, and also a large quantity of coals. In fact, the bulk of the manufacturers of Manchester have relied upon the canals for their supply of both coals and water, and, in the absence of stores of their own, they will be put to great inconvenience by the threatened drying up of their resources. Since the above was written we are informed that the Macclesfield Canal has been reopened, but at present there is only water sufficient for three or four days' working.—*Times*, Sept. 21.

## THE PHILADELPHIA GASWORKS.

John C. Cresson, *Engineer.*

(*With an Engraving, Plate* XXXVI.)

The consumption of coals in the United States for gas purposes is largely on the increase. On the seaboard a large proportion is obtained either direct from Great Britain or from the bituminous coal deposits in the British North American colonies. In the Atlantic States, south of New York, the oolite coal field of Virginia furnishes a portion of the necessary supplies, the remainder being generally obtained from this country. In the States west of the Alleghanies the entire supply is obtained from the nearest coal field. Owing to the expenses attending the transport of the raw materials, and the difficulty in disposing of the secondary products, the prices charged for the gas are in general very much higher than in England. In all cases, however, it has been found that a reduction in the selling price has been immediately followed by an increased consumption. The common ⌂ shaped iron retort is in general use. In one or two establishments clay retorts had been tried, but have not worked so well as the others. The following is a summary of details of manufacture in the establishment at Philadelphia

These works are in the hands of the Municipal Corporation; capital invested 1,400,000 dols., originally commenced and carried on as private undertaking, and subsequently purchased by the city; its direction and general government being vested in a board of trustees, by whom it has been carried on since that period. Mr. Cresson is the engineer, under whose management the works have reached their present state of prosperity and efficiency, and under whose superintendence the new works have been erected. These are remarkable, not more on account of their magnitude than on account of the combination of engineering skill with ornamental finish, which Mr. Cresson has displayed in their arrangement. As a gasholder of this magnitude in England is rare, and as some novelties in construction have been introduced with perfect success into this one, we give engravings of the gasholder, with descriptive working details.

*Description of Gasholder at the Philadelphia Gasworks*—The following are the dimensions and working details of the great telescope gasholder at these works. It is 160 feet in diameter, and 90 feet high, with 12 guide towers built of cast-iron and stone, in an ornamental form The *inner or upper section* is 158 ft. 6 in. diameter and 45 feet deep (20 rows of sheets, 16 rows of No. 12, 2 rows of No. 11, and 2 rows of No. 10.

Bottom angle iron, 3" × 3" × ½ } Cup, No. 10 sheets and butts, 20 inches
Outer angle iron, 3" × 3" × ½ } deep and 6½ wide in the clear.

24 legs of cast-iron, each in five lengths.

Top curb (angle iron), 4" × 4" × ½; 3 rings of angle iron at equal distances, 2½" × 2½" × ½.

48 guide-plates, riveted to the legs with hot rivets 4" × ¾.

Crown, straight rise of 4 feet to centre.

Crown-plate, 4 feet diameter by ½-inch thick; 16 rows of sheets; crown-rows Nos. 8 and 10; rest No. 12, except the outer which is No. 11.

King-post, No. 3, boiler iron 25 feet long and 30 inches diameter; top ring, 4" × 4" × ½; bottom ring, 4" × 4" × ½.

Two rings for nut at end of bolt, 4" × 1"; bottom plate ⅜-inch thick.

All bolts and nuts for crown end of bars, 1¼".

Crown to be on 7 rings of plate and angle iron.

No. 1 plate, 3" × ⅜. No. 2 angle, 3" × 3" × ⅜. No. 3 plate, 3" × ½. No. 4 double angle T 3" × 3 × ⅜, so arranged as to break joint. No. 5 plate, 4" × ½. No. 6 angle, 3" × 3" × ⅜. No. 7 plate, 4" × ⅜.

All plate-rings secured at the joints with butt plates.

24 trusses of round and square bar iron, each truss having 7 struts. On 1st and 2nd ring, 1¼ inch square; on 3rd ring, 1 inch square; on 4th (main strut), bars of 3" × ⅜", riveted at distances of 1 foot, and blocked apart with ⅜" washers; on 5th and 7th, double struts of 1 inch square bars; on 6th double struts of plate; each leg two bars of 2" × ½", similarly secured with No. 4 (see drawing) round iron tension rods of sizes marked in drawing.

The crown to be enclosed in a wrought railing 16 inches high; 2 rails of 1 inch round iron, and secured to the outer angle iron by 48 staunchеons braced with 48 ½-inch round rods.

*Lower Section.*—160 feet diameter, and 45 feet deep; sides, 20 rows of sheets (17 rows of No. 14; 1 row of No. 11; top row No. 10; bottom row No. 12).

Cup, same as upper section; bottom angle iron 3" × 3" × ½".

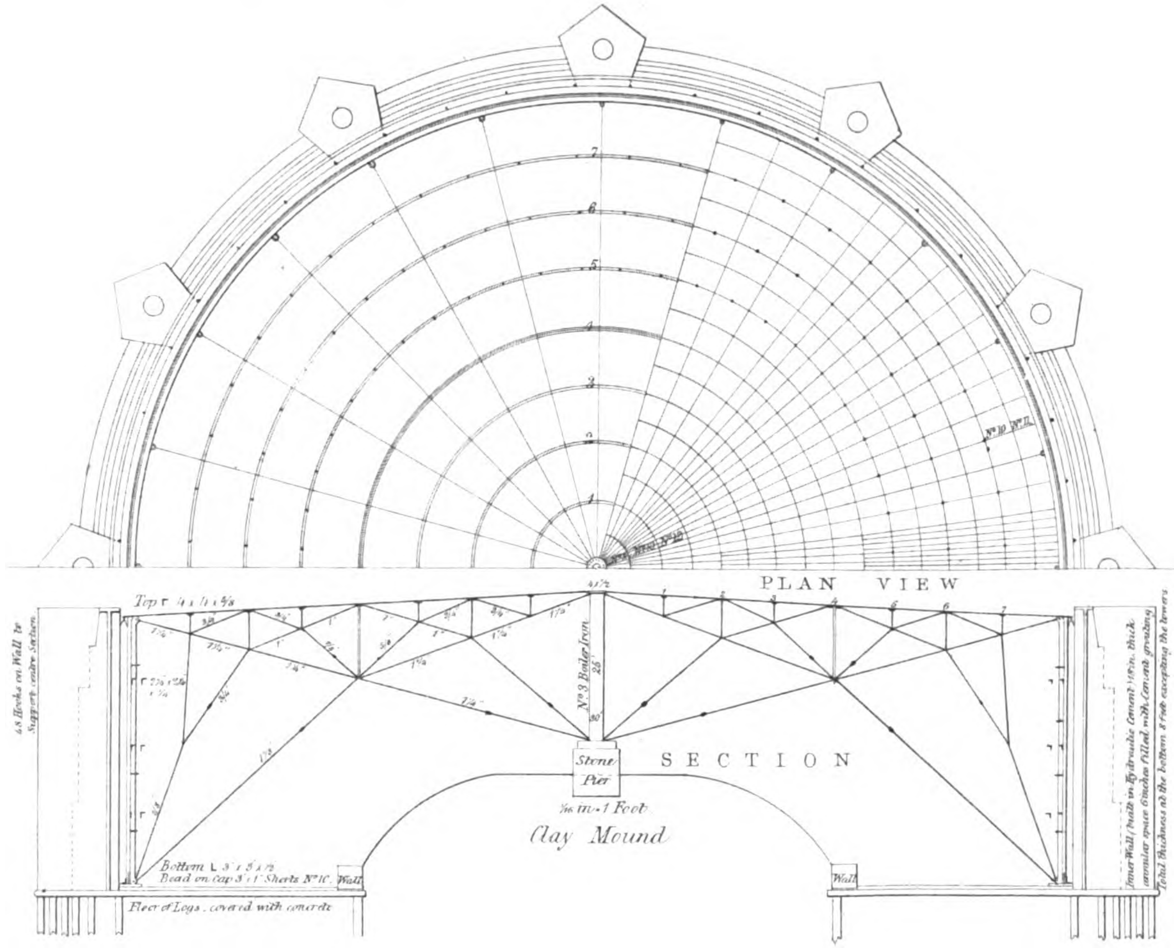
24 rollers and carriages on the cup between the sections.

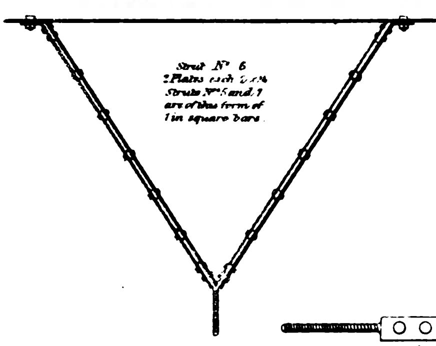
24 rollers and carriages on the cup on guides.

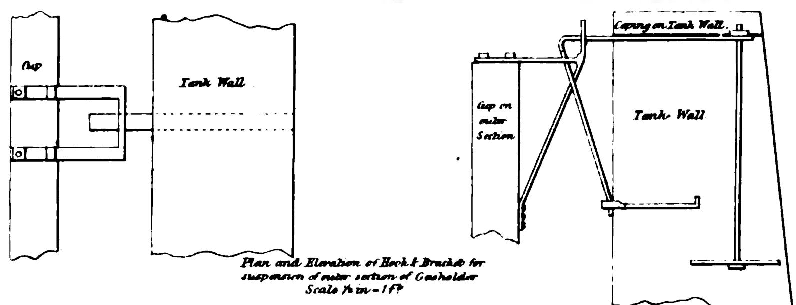
36 hooks for suspension from the tanks.

Aggregate make (1852), 232,000,000 feet; present price $2 per 1000 feet.

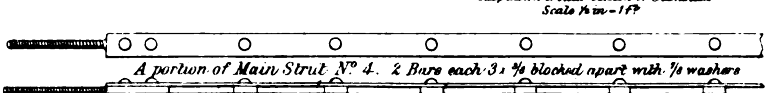
# TELESCOPE GASHOLDER AT THE PHILADELPHIA GAS WORKS



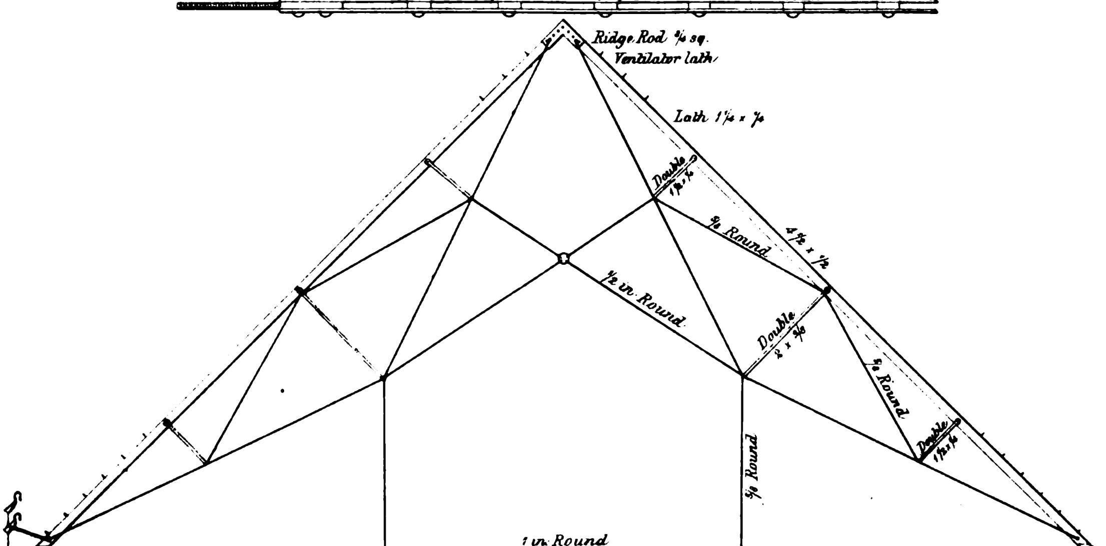




Plan and Elevation of Hook & Brackets for suspension of outer section of Gasholder Scale ½ in = 1 ft



A portion of Main Strut No 4. 2 Bars each 3 x ⅜ blocked apart with ⅞ washers




ONE HALF OF SKELETON ROOF OF RETORT HOUSE.

Street-lamps charged $20 per annum; average consumption of each, 28,000 feet; the city lighting, &c.

The coals used are the oolite from Richmond, Virginia; the West Pennsylvania coals from Pittsburg; the Pictou; and English, from Newcastle and Wigan, in various proportions, giving an average produce of 4 cubic feet per lb. of coal. The Richmond coal yields from 3·92 to 4·5 feet per lb.

The secondary products are not very remunerative; gas tar is readily saleable at 50 cents per barrel of 30 gallons; the coke meets with a heavy sale at 5 cents per bushel; the lime costs 3 cents per bushel, and sells readily to the farmer at the same price; the ammonia liquor is given or thrown away.

Labourers, chiefly Irish and German; wages average about—firemen, $9¼ = 2*l.* 0*s.* 8*d.* per week; labourers, $1 12c. = 4*s.* 8*d.*; and mechanics, $2 per day.

## FIRE-EXTINGUISHING WORKS IN DOCKYARDS.

TO BERNAL OSBORNE, ESQ., SECRETARY OF THE ADMIRALTY, ETC.

Sir,—The late conflagration in Chatham Dockyard induces me again to call the attention of the Lords of the Admiralty to the fire-extinguishing works in her Majesty's dockyards, and to the expediency of instituting and of enforcing regulations for their conservancy and frequent use.

I know that in Chatham-yard, fire-extinguishing works were constructed conformably to the late Sir Samuel Bentham's plans, that they were similar to those he devised in the last century, and shortly afterwards introduced in Portsmouth-yard. I know that by means of these works, fire was frequently extinguished on several occasions. I also speak from unquestionable authority when I assert, that one of Sir Samuel's important provisions has fallen into desuetude in that dockyard, namely, the throwing water over a burning mass *directly* from hose screwed upon the fire-cocks, without the intervention of engines worked by men; and it may be observed, that, however well hand-engines are distributed in that yard, and however speedily manned by day, they would be of no avail whatever by night until, to work them, men from without could be roused from sleep and assembled in the yard.

For the extinction of the disastrous fire at Chatham, I understand that hand-engines only were employed, and I have reason to believe that the proper use of Sir Samuel's fire-extinguishing works was altogether unknown. The value of the property consumed I have no means of estimating; still less can I know the depredations that resulted from the admission to the yard of a host of strangers, or the delays to the economical progress of general service resulting from the destruction of so much machinery.

That machinery was not erected till after the abolition of Sir Samuel's office, or surely he would have introduced for its protection the same expedients that he had devised for the wood mills at Portsmouth—namely, on every floor pipes leading from an elevated reservoir, and hose attached to them, so that, on the outbreak of fire, water could instantly be thrown upon it by simply turning a cock.

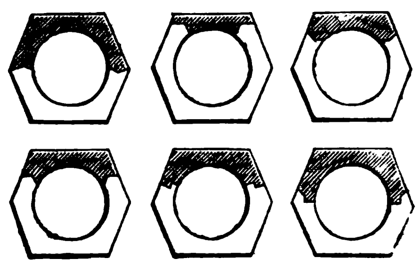
There is reason to believe that the fire-extinguishing works in both Plymouth and Sheerness Dockyards have not been kept in working order; but in Pembroke-yard they appear to be well attended to—and mark the contrast. A fire broke out at Pembroke-yard in the boatswain's cabin about *midnight*, on the 25th January, 1853. This fire was discovered by the police. A sergeant of that force immediately threw a *bucket* of water upon the burning matter, which was quickly succeeded by more water in *buckets*, which sufficed to keep the fire in check until a *hose was screwed on the fire-cock* at a short distance from the spot. The time consumed in bringing that hose to use was no more than about *ten minutes* after the discovery of the fire, thus it appears that the fire was promptly extinguished by the fire-extinguishing works alone.

I would again venture to suggest, that as no persons other than the police are likely to be by night in every part of a dockyard, the police it should be that should be familiarised with the application of the hose, and that, to do so, no means seem so effectual as that of accustoming them to use the fire-extinguishing works for as many purposes as possible; for instance, for watering the yard, for washing store-house windows and the fronts of buildings, &c.

*Hampstead, August 16th*, 1854. M. S. Bentham.

## AUSTIN'S PATENT HEXAGONAL SEPARATING DRAIN-PIPES.

The object of this invention is to afford ready access for clearance from any obstructions, and to prevent the present waste by breakage consequent upon the clearing of socketed pipes. These tubes are also available for casing over telegraphic wires, for service-pipes for gas, water, &c., the latter now rapidly corroding and decaying from contact with damp ground.



In the accompanying sections, the scored or cross-line portions show the separating joints or divisions which resist lateral or side thrust. The tiles or pipes, when packed, form close stowage, saving one-third room over round pipes, and avoiding rolling and breakage.

On this form of construction (honeycomb) Mr. Austin has also patented casks or barrels for dry and wet goods, forming thereby compact stowing on board ship in dock or warehouse.

## REPORT OF THE COMMISSIONERS OF PATENTS.*

In pursuance of several orders of the Commissioners of Patents, the whole business of the Commissioners relating to patents, from the petition for the allowance of provisional protection to the printing, publication, and sale of the specification, is now conducted in one office.

The office of the Commissioners is in Southampton-buildings, Chancery-lane, in a set of chambers lately occupied by the Masters in Chancery, and is open to the public from ten to four o'clock every day.

The number of applications for provisional protection recorded within the fifteen months from the 1st October, 1852, to the 31st December, 1853, was 4256; the number of patents passed thereon, all having become due on the 30th June last, was 3099; and the number of applications lapsed or forfeited, the applicants having neglected to proceed for their patents within the six months of provisional protection, was 1157.

The number of applications recorded within the first three months of the operation of the Act, was 1211.

The number of applications recorded within the year 1853, was 3045.

Though the Act received the royal assent on the 1st July, 1852, yet its operation was deferred to the 1st October following. During the intervening period almost all applications for patents were suspended, and this sufficiently accounts for the large number of applications (1211) recorded within the quarter ending 31st December, 1852, compared with the number (3045) recorded for the whole year 1853.

The number of applications recorded in the first six months of the current year, was 1440, showing a probable decrease of 165 applications upon the year 1854, as compared with the number of the year 1853.

All the specifications filed in the office upon the patents passed under the Act from 1st October, 1852, to the 30th June last, 3099 in number, have been printed and published, together with lithographed outline copies of the drawings accompanying the same; and these are sold to the public, either separately or in the series for the year, at the cost price of the printing and paper. The price of a specification of the average length of letter-press, and drawings, is eight-pence.

There is no arrear in the printing and publication of the specifications filed since the commencement of the Act. Each specification is printed and published within three weeks of its deposit in the office.

Under the 15 and 16 Vict. c. 115 s. 4, a printed copy of the

* Compiled from the Report presented to Parliament, August 7, 1854.

specification, duly certified and sealed in the commissioners' office, may be received in evidence of the original document in any court within the United Kingdom of Great Britain and Ireland and the colonies; the printed copy is certified on payment by the applicant of one shilling for the seal, and the charge of the draughtsman for colouring the prints of drawings is paid by the applicant.

Printed certified copies of all the specifications filed in the office from the 1st October, 1852, to the present time, with coloured printed copies of the drawings, have been sent to the office of the Director of Chancery in Edinburgh, and the enrolment office of the Court of Chancery in Dublin, pursuant to the Act, 1852, and the Act 16 and 17 Vict. c. 115; and such copies are open to the inspection of the public in the respective offices.

Certified copies of all the patents passed since the commencement of the Act, and certified copies of the record books of assignments of patents and licences, with copies of such assignments and licences, have also been sent to the Chancery offices in Edinburgh and Dublin, pursuant to the Act.

The whole series of specifications of patents for reaping machines, and drawings accompanying the same, from the first enrolled, 4th July, 1799, to the present time, have been printed and published, and are sold at the cost price of the printing and paper, either separately or altogether, with an appendix in one volume. The appendix, compiled by Mr. Woodcroft, from a great variety of authorities and works, describes the instruments for reaping grain published and in use, from the earliest period to the present time.

The whole series of specifications of patents for firearms, cannon, shot, shell, cartridges, weapons, accoutrements, and the machinery for their manufacture, and the drawings accompanying the same, from the earliest recorded, 15th May, 1718, to the present time, have been printed and published in like manner. An appendix is in preparation, and will shortly be published.

The Secretary of State for the Home Department has required the publication of all the specifications of patents for the consumption of smoke in furnaces, and for the making of drainage tiles applicable to sewerage; and the Board of Admiralty has required the publication of the specifications of patents for improvements in propelling ships; these three subjects are now in preparation.

Pending the publication of the old specifications, necessarily a work of time, printed certified copies for evidence in courts of justice, for counsel, and for other purposes, of any of the old specifications, may be obtained on application at the Patent Office, the applicant paying the cost of putting the drawings upon the stone and colouring the number of prints he may require, and the Commissioners paying the cost of letter-press and paper, or, in the absence of drawings, the applicant paying the cost of letter-press and paper; by this arrangement, the applicant obtains twelve or fourteen certified printed evidence copies at a low price, and the Commissioners obtain the prints of drawings, or the letter-press and paper for their future publication of the specification, free of cost. 100 old specifications have been printed in this manner within the last few months.

Mr. Woodcroft's chronological and alphabetical indexes of all the specifications of patents enrolled in Chancery, from 1617 to the 1st October, 1852, 14,359 in number, have been published in three imperial octavo volumes, and are sold at 50*s.*, the cost price of printing and paper. Mr. Woodcroft's index, arranging these specifications according to the subject matter, is in the hands of the printer, and will shortly be published.

Indexes in the same chronological, alphabetical, and subject-matter form of all the specifications filed in the office under the new law, will be made in continuation, and published periodically.

The prints of specifications, the indexes, and all other printed papers, will in future be sold in the Patent Office, and not at the Queen's Printers as heretofore. The publications are sold to all persons applying for them at the cost price of each, and no trade discount is allowed. Booksellers and agents, however, charge a commission to the persons for whom they purchase these works.

The Commissioners have established a public library of research within the Patent Office, to consist of the scientific and mechanical works of all nations; convenient rooms are provided for the purpose, and the library will be open to the public within a few weeks.

A journal, entitled *The Commissioners of Patents Journal*, has been published twice a week since the commencement of the present year, and it will be continued. It contains the various notices appearing in the *Gazette* on the subjects of patents, and a variety of other notices and useful information and instruction for the guidance of applicants in proceeding for their patents. It is proposed to publish in the journal the names of patentees, and the titles of patents granted in other countries; also a notification from time to time of the date of the expiration of each patent as it may become void, either by reason of non-payment of the stamp duties of 50*l.* and 100*l.* at the expiration of the third and seventh years respectively, pursuant to the Act, or at the full term of fourteen years; and also from time to time a list of the inventions provisionally protected, lapsed or forfeited by reason of the applicants having neglected to proceed for their patents within the six months of provisional protection. The price of the journal to subscribers, is 30*s.* per annum.

## THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The twenty-fourth meeting of the British Association commenced at Liverpool on the 20th ult. It had been previously arranged that all the proceedings should take place in St. George's Hall, but this was found to be impossible, in consequence of the musical performances with which the inauguration of the hall was celebrated; and the first general meeting of the members therefore took place in the Philharmonic Hall, which is scarcely less capacious than the more pretensious and more highly-decorated hall in which they were first appointed to assemble. The muster of members seemed small when spread over such an extensive area, but there were about 1200 in the room, the number being nearly double that of the Hull meeting last year. The President for this year (Lord Harrowby) was inducted into the chair by Mr. Hopkins, and then read a paper on the progress of science during the past year, the matter, as he said, having been supplied to him by different gentlemen eminent in their respective branches of study. At the conclusion of the President's address, which was, under such circumstances, less interesting than usual, the thanks of the meeting were proposed by Lord Derby, in a speech that had no pretension to scientific illustration, and in which his lordship said he had been educated in the pre-scientific age. Sir Charles Lyell, in seconding the motion, alluded, rather more pointedly than seemed agreeable, to the former absence of scientific education in the University of Oxford, and expressed a hope, that from the gleams of improvement which were now visible, there would result a system of education better adapted to the present state of knowledge.

On the following morning the different sections assembled, but in consequence of the want of time to make preparations, several of the rooms appropriated for the purpose were unfinished, and at the time fixed for the meeting of the Mechanical Section, carpenters were at work finishing the wooden benches and tables; nor was it till nearly 12 o'clock that the place where the members were to assemble was ready for them. The Physical Section was nearly as unfinished, and over a large portion of the room there was no ceiling. St. George's Hall has, in fact, been opened too soon, and the want of completeness is evident in many parts. The place appointed for the Mechanical Section was an open hall at the north entrance, and the proceedings were continually interrupted by the noises of persons passing through to other sections. The following is a list of the officers appointed for the Mechanical Section:—

*President.*—John Scott Russell, Esq., M.A., F.R.S.

*Vice-Presidents.*—William Fairbairn, Esq., M.A., F.R.S.; Joseph Locke, Esq., M.P.; James Nasmyth, Esq., C.E.; Professor Walker, F.R.S.; Henry Booth, Esq.; John F. Bateman, Esq., F.G.S.

*Secretaries.*—James Oldham, Esq., C.E.; John Grantham, Esq., C.E.; James Thomson, Esq., C.E.

*Committee.*—Dr. Scoresby, F.R.S.; George Lowe, F.R.S; John George Appold, F.R.S.; John S. Enys, F.R.S.; Richard Roberts, C.E.; John Laird, Esq.; John Vernon, Esq.; W. G. Armstrong, C.E.; Walter F. Macgregor, C.E.; C. W. Williams, Esq.; John Hick, C.E.; Joseph Whitworth, Esq.; Alfred King, Esq.; R. B. Grantham, F.G.S.; Andrew Henderson, Esq.

On the meeting of the section on Thursday morning, the President stated, that in consequence of some of the members who had sent in papers not being prepared, and others being absent, the proceedings would be adjourned till the following morning.

The said committee had been enabled, however, to classify the subjects so as to appoint separate days for each. Friday would be appropriated to naval architecture and steam navigation; Saturday to the combustion of fuel and to steam-boiler explosions; Monday to railways and telegraphs; and Tuesday would be appropriated to miscellaneous subjects. On the following morning the President opened the proceedings of the section by a communication

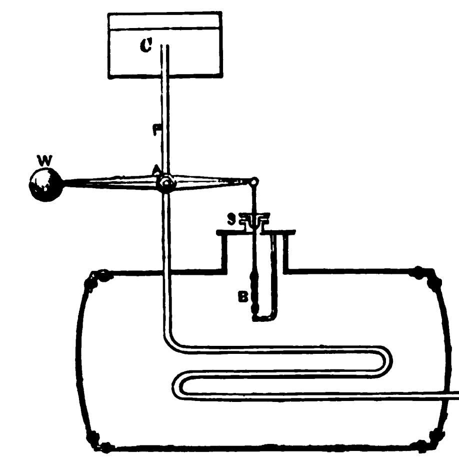
ON NAVAL ARCHITECTURE AND STEAM NAVIGATION.

Mr. Russell commenced by explaining the elementary principles of navigation, and the forms of ships requisite to produce stability, speed, and windwardness. He then entered into the consideration of the wave principle of construction, and stated the important part which the British Association had taken in establishing that principle. He mentioned as a striking instance of the difficulty with which old prejudices are removed, that formerly, on the capture of smuggler vessels, which were built on the plan of having long concave bows and bluff sterns, such a shape being considered exactly contrary to what a ship ought to have, the helm was changed, and the ship was made to sail stern foremost. When shipbuilders came to be more enlightened on the subject, they found that they must have a hollow water-line at the bow. There was in addition to this, another very important principle which had been discovered. That was, the virtue of length. If you wanted the particles of water to go out of the way of the vessel when going very fast, you must allow the particles time to do so. It was found that it was more easy to push a vessel with an elongated body through the water at great speed, than the short vessel which had been in use. This was reduced to a regular principle, the result of which was that it was now certain that 24 feet of length in the entrance lines of a vessel would give eight miles an hour easily; to go at sixteen miles an hour, the entrance lines should be nearly 96 feet; to give twenty-four miles an hour, the entrance should be 216 feet. They could not therefore expect to get twenty-four miles an hour until they had made up their minds to build ships something like 400 feet long. Now, from all the experiments he had made, and had seen made, these facts were undoubted; they would therefore perceive why such a large vessel as the *Himalaya* had such great speed. The *Himalaya* had a length of 350 feet, and had obtained the greatest speed for the smallest power, of any merchant vessel hitherto. If, in a like manner, they looked at the large clipper ships of 2000 and 3000 tons burthen now built, they would find that the principle was taken advantage of, and that their bows were elongated to a great length. The difficulty of building large ships was, however, increased by the want of materials sufficiently large for strength, until the adoption of iron. It had not yet been found practicable to join planks of wood together sufficiently strong to obtain the strength of an uniform plank, and until this was done, they could not safely use timber for building large ships. But by employing iron they would have an equally strong material of any size, the joints being almost stronger than the plates. There was a very distinguished man in that neighbourhood, Mr. Ashton Smith, and a very distinguished shipbuilder, Mr. Laird. Mr. Smith thought nothing of building ships of 120 horse-power and 600 tons burthen, merely to see how they would go, and he had had the idea at exactly the same time that the British Association were carrying on their researches, that the long hollow line was good for something. Mr. Smith endeavoured to try it, and set about inventing such a ship, and he accordingly built one, which was the first ship that went fifteen miles an hour. Mr. Laird very early coincided with Mr. Ashton Smith in his views regarding the hollow line, and very speedily adopted it, and, he believed, had made a great many ships on that principle. Mr. Vernon and Mr. Grantham had built such ships, and Liverpool upon the whole had contributed in a very fair degree towards the introduction of the new principle in shipbuilding, and he hoped that their discussion here would encourage shipbuilders not to be afraid, not to keep it a secret, but to go boldly and openly upon the hollow water line, and the more they did so, the faster they would go. Having alluded to the building of the *Great Western*, and subsequently of the *Great Britain*, and the prophetic doubts expressed at first regarding the fate of each, the President proceeded to describe the great vessel now being built by him on the Thames for the Eastern Steam Navigation Company, to trade with India and Australia. He showed how the difficulty of carrying coals, and having to stop for them and buy them at high rates at St. Vincent, the Cape of Good Hope, and sometimes the Mauritius, created such an expense that no freights could cover; he showed how it became necessary to construct a vessel large enough to carry her own coals all the way. When, therefore, he told them that the vessel being constructed, was expected to make the voyage in thirty days, carrying a freight of 6000 tons, with 500 first-class, 600 second-class, and 1000 third-class passengers—having three tiers of decks, eight feet each in height—that she was 675 feet long, 83 feet beam, 60 feet deep; when he told them that he had just measured St. George's Hall, and found that it would not fairly represent this ship, being 169 feet instead of 675 feet long—that up to the top of the hall it was only 82 feet high, and up to the spring of the arch about the height of the ship—that the breadth of St. George's hall was only 77 feet, being 6 feet narrower than the hold of the ship, it would give them the nearest approximation he could convey to the size of the vessel.

Mr. Fairbairn said he was one of those who had had doubts whether a ship of that size could be built of sufficient strength; but having seen all the plans, he now felt persuaded that it would not be deficient in the requisite strength. It would be constructed on the same principle as the Britannia bridge, and when they saw that structure sustaining itself without bending, though it had no intermediate support, there could be no doubt that that large ship would be able to bear a gale of wind without bending.

PREVENTION OF BOILER EXPLOSIONS.

Mr. H. Dircks read a paper on the Prevention of Boiler Explosions. The plan he proposed is a modification of the fusible plug, by employing a chain that holds a weight, one link of which is made of fusible metal. When the heat of the steam in the boiler is raised above the point at which it is intended the boiler should be worked, the link of the chain gives way, the weight pulls open a stop-cock, and admits a current of cold water through a tube that passes through the boiler, and thus diminishes the heat and reduces the pressure. The accompanying sketch will

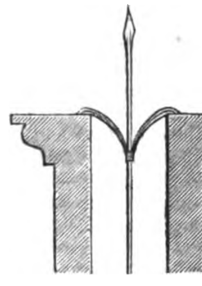



best explain the mode of operation. The pipe P, coming from the cistern C, passes through the boiler; and when the stop-cock A, is opened, a current of cold water is sent through the tube in the boiler. The link B, of the chain is made of fusible metal, and when the heat becomes too great, the metal is melted, and the weight W, opens the stop-cock. A stuffing box S, is introduced, through which the connecting-rod passes.

In the discussion that followed, the invention seemed to be considered of a nature not practically useful, and to participate in the defects of the fusible plugs which have been before tried without advantage.

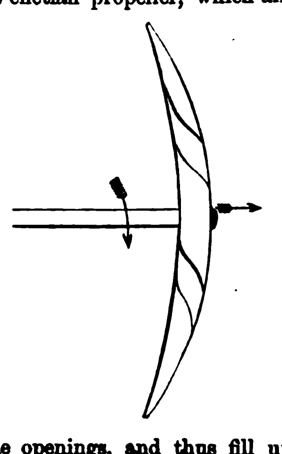
LIGHTNING CONDUCTORS.

Mr. Nasmyth read a paper on Lightning Conductors as applied to tall chimneys, and explained a mode of fixing such conductors for the purpose of securing more perfect insulation. The common plan of fixing a metal rod on the outside by holdfasts into the brickwork has been frequently attended with accidents, the lightning having entered the chimney at the points of attachment, and torn away the bricks so as to do great damage. The plan proposed by Mr. Nasmyth removed this difficulty by suspending the lightning-conductor inside the chimney. The mode of doing this is sketched in the accompanying figure. He said that a tall chimney thus protected had stood uninjured during several severe thunderstorms, whilst chimneys in the neighbourhood protected in the usual manner had been damaged. A short discussion took place on this plan of insulating conductors. Professor Faraday stated that it agreed with his views, which were that lightning-conductors should always be placed inside buildings, and not on the outside. He had been consulted on the question of placing the lightning-conductor on the Duke of York's pillar, and he then recommended that it should be placed inside, but his advice was disregarded. The practical part of the question which more particularly required attention to be directed to it in the Mechanical Section was, to avoid as much as possible the introduction of metal-work detached from the conductor. In the fixing of stones by running lead at the joints, there is considerable danger, unless there be a continuous metallic conductor leading from such metallic fastenings to the earth. The introduction of glass insulators between a lightning-conductor and the wall of a building is an absurdity, as the very short distance from the conductor to the brickwork compared with the distance the lightning passes from the clouds to the earth, is insignificant.



### VENETIAN SCREW PROPELLER.

Mr. GRANTHAM read a paper on Mr. Fisher's Venetian Screw Propeller, so called from the blades of the screw having openings like those of a Venetian blind. Mr. Grantham said, that in the use of the common screw propeller, the action of the blades on the water produces a kind of vacuum at the back, which resists the onward progress of the ship; and it was to avoid this that Mr. Fisher had invented the Venetian propeller, which allowed



the water to pass through the openings, and thus fill up the counteracting draught of water. This propeller had been tried successfully in the Birkenhead docks, and it had also been applied experimentally to her Majesty's yacht the *Fairy*, with promising results. The accompanying woodcuts represent two views of the propeller: one as seen in section, and the other showing the number and directions of the openings in a single blade.

### THE VENTILATION OF EMIGRANT SHIPS.

Mr. JOHN CUNNINGHAM read a paper on the Ventilation of Emigrant Ships, and explained a plan invented by Mr. William Ashley, for giving more perfect ventilation; and for thus avoiding the injurious effects now frequently produced by the over-crowding of such ships. The supply of air to the cabins is effected by two fans worked by a three horse-power engine, so as to produce 450 revolutions per minute. The air is forced down a main air-shaft to side trunk-flues, which extend along each side of the vessel. Small branch flues to the cabins, and other parts of the ship requiring ventilation, are joined into the main trunk-flues. Each is provided with sliding or revolving ventilators to regulate the requisite amount of supply. There is a vessel at the top of the section for disinfecting or for cooling the atmosphere. A tank at the bottom is charged with water containing the disinfecting fluid, and a truncated cone, termed a sprayor, is inverted with the smaller end into the fluid; its upper end spreads out, and is perforated. This vessel rotates rapidly, and the fluid by the centrifugal force is drawn up and thrown out in spray, through which the air must pass into the fanners, thus becoming impregnated in its passage with the disinfecting material, such as the chloride of zinc or of lime. By placing a few bucketfuls of ice per diem in the tank, the water may be cooled, and, consequently, the air reduced in temperature. The cost of providing a steam-engine, boiler, and apparatus complete, including flues, &c., for a ship of 1500 tons burthen, similar to the plans exhibited, is estimated at between 250*l.* and 300*l.* The quantity of fuel required to keep the engine at work night and day for 100 days would be about twenty tons. In addition to the process of ventilation, it is proposed also to adapt the engine to several other purposes, such as the loading and discharging of the vessel, lifting the anchors, pumping the ship, and supplying water to the waterclosets, and for cleaning the decks. Further, it is proposed to apply the waste steam to the purposes of cooking.

## ACTION OF SEA-WATER ON CEMENTS.*

By MM. MALAGUTI and DUROCHER.

FOR several years past the attention of scientific men and of engineers has been occupied with the question of the destructive action exercised by sea-water upon hydraulic mortars. M. Vicat, in seeking to explain this disastrous phenomenon, has shown that the sea-water acts by its tendency to dissolve the lime of the mortars, which is then replaced by magnesia; but hitherto no efficacious means have been pointed out to prevent or neutralise this dissolving influence. We only know, in general, that the strongest hydraulic mortars, the cements or mixtures of lime and puzzolanas, which have set the most rapidly, are those which appear to best resist these causes of decomposition. Nevertheless, even amongst mortars and cements which set with equal rapidity and are of nearly equal strength, it will be found that some possess very different powers of resistance, without its being possible *a priori* to distinguish, either by analysis or a quick trial, those on the stability of which complete confidence may be reposed.

In this state of uncertainty, we thought that, by the study of the cements which resist the decomposing action of sea-water conjointly with analyses of the hydraulic limes and cements incapable of withstanding its action, as well as of the products of the resulting decomposition, it might be possible to throw some light upon this question, whose difficulty is equal to its importance.

The samples, sixteen in number, upon which we experimented were the hydraulic limes of Paviers and Doué, and the mortars made from them, Boulogne, Portland, Pouilly, Vassy, and Parker's cements. We are indebted for them to the kindness of those skilful engineers of the Ponts et Chaussées, MM. Jebuvier, Watier, and Bellanger, to whom we desire to express our thanks.

The mode which we have followed in our researches consisted in examining the modifications which were produced in the proportions of the different elements, in comparing the compositions of the substances plunged in sea-water with that of similar substances which were not immersed. But as we had no samples of mortars of lime and sand which had set under fresh water to compare with those immersed in sea-water, the examination of the latter could only be made by comparing their composition with that of the lime employed in their preparation. In these comparisons we had to deduct the sand, and to reduce the compositions found for the mortar to those which they would have had if no sand had been used. We shall not detail here all the results which the discussion of our analyses revealed to us, and which are recorded in our complete memoir; we shall merely direct attention to the most prominent ones, which prove how complicated these phenomena of decomposition are.

Two cylinders of the hydraulic lime of Paviers were immersed, under similar conditions, in sea-water during eighteen months.

* 'Remarks on the Resistance offered by Hydraulic Limes and Cements to the Destructive Action of Sea-Water.' By MM. MALAGUTI and DUROCHER. (Comptes Rendus de l'Académie des Sciences, 24th July 1854).—From the 'Dublin Monthly Journal of Industrial Progress.'

PERSPECTIVE VIEW OF THE TOWN HALL, BUILDINGS & MARKETS, BRADFORD, WILTS.

One of them lost an enormous quantity of lime and gained little magnesia; but to compensate for this, it fixed a quantity of carbonic acid almost sufficient to saturate the two earthy bases. An appreciable quantity of silicic acid was carried off with a little alumina. It appeared that a hydrated silicate of alumina was separated from the mortar at the same time with the lime, whilst carbonic acid was substituted for the constituents which disappeared. The alteration of the other cylinder was not so considerable; the loss in lime, and the gain in carbonic acid, were not so great; but, on the other hand, the quantity of magnesia substituted for the lime was double, and a little more silicate of alumina was abstracted. The same phenomena were observed with a mortar made with this lime.

Two prisms of this mortar were immersed during eighteen months in sea-water. One of these prisms had no appearance of a well-marked alteration, whilst the second was in a very advanced stage of decomposition. It was found that some lime had, nevertheless, been eliminated, that a considerable proportion of carbonic acid had been fixed, and that the proportions of magnesia, silica, and alumina had not undergone an appreciable change. The prism in which the alteration was considerably advanced had undergone a true transformation in respect to its composition. A considerable quantity of lime was replaced by more than an equivalent quantity of magnesia, and the carbonic acid had not sensibly changed; on the other hand, the silica and alumina had appreciably augmented.

Are we to seek for an explanation of these so different results in the non-homogeneity of the hydraulic lime which had served to make the experiments? We may remark that, in the deposit of Paviers, the different beds of hydraulic limestone have not the same composition. The alteration which the mortar produced from the lime of Doué underwent, consisted in the loss of a considerable quantity of lime, without the substitution of magnesia, and by the fixation of a great quantity of carbonic acid.

With regard to the alteration of cements, that of Boulogne, previously moistened with fresh water, began to crack after an immersion of eight months in sea-water; nevertheless, its chemical composition did not sensibly change. It was quite different with Portland cement, which cracked in every direction under the action of sea-water, fixed as much carbonic acid as it contained in its normal state, and, finally, it had lost a little lime, which was substituted by a very small quantity of magnesia. Lastly, a mortar prepared with one volume of Portland cement, and two volumes of quartzose sand, immersed during a year in sea-water, exhibited no trace of alteration, unless it gained some carbonic acid.

In fine, the facts which we have brought forward, and all those which are detailed in our memoir, prove that the decomposition of limes, cements, and mortars by sea-water, do not constantly take place in the same manner; the substitution of magnesia for lime takes place sometimes, but not always, and as it is accompanied by the addition of carbonic acid, the altered mortar consists of a hydro-silicate of alumina, and of a double carbonate, which tends to approach dolomite in composition. But there are cases where the lime disappears without the introduction of magnesia, and the phenomena appears then to occur as if it had been produced in water free from salt, but charged with carbonic acid. Further, in the alteration effected in mortars moderately hydraulic, there is a division of the constituents of the mortar into two compounds, the one rich in earthy carbonates, the other rich in alumina, coming to the surface and forming a snowy deposit, which the waves remove. This partition is not effected, or at least it only takes place very slowly, in the very hard and rapidly setting cements or mortars. The alteration which is produced in the latter consists in a simple cracking of the mass, and in the disappearance of a small quantity of lime, with or without its being substituted by magnesia, and in both cases there is a tendency to diminish in volume, whence results the cracking of the mass.

It only remains for us to speak of those cements which are considered to best withstand the action of sea-water. Hitherto the cements of Pouilly, Vassy, and Parker have been looked upon as the most stable. A circumstance struck us in the analysis of these three cements: it is, that they are very rich in oxide of iron, and that that of Parker, which is the best resisting, is exactly the richest. We have, in fact, found 7 per cent. of oxide of iron in the cements of Pouilly and Vassy, and nearly 14 per cent. in that of Parker. Hence we have been led to consider whether the presence of oxide of iron does not powerfully contribute to give to those cements the property of resisting the decomposing influence of sea-water. In order to justify this opinion, it became necessary to institute experimental researches, by making ferruginous cements and exposing them to the action of sea-water. But before doing so, we had to ascertain whether oxide of iron contained in cements and mortars did not behave as an inert substance. Thus we had to examine how far this oxide was capable of forming, in the humid way, combinations with lime. With this object in view, we formed directly kinds of puzzolanas. by making mixtures of silica and a little lime with alumina and oxide of iron, and then studied the action of lime-water on these mixtures, previously heated to a dull redness. After immersion for some time, these substances augmented in volume, and possessed the most remarkable characters. Each of them divided itself into two distinct compounds, one of which attached itself to the bottom of the flask, and had gained considerable cohesion and adherence; whilst the other assumed a flocculent aspect; it swelled out more and more, and rose to about 15 or 16 centimetres above the bottom. In analysing these different compounds, we have found that the quantity of lime precipitated is independent of the presence of alumina, whilst it is augmented by the presence of oxide of iron. Further, we have recognised that the flocculent compound was the richest in alumina, and that the concreted deposit was richest in oxide of iron.

These synthetical experiments having apparently demonstrated that oxide of iron is not an inert constituent of hydraulic cements, we believe that we may conclude that the presence of this oxide would contribute to give stability to mortars and cements immersed in sea-water. It remains, in fact, to be ascertained whether cements or artificial hydraulic limes, formed by the addition of lime to ferruginous clays, or mixtures of clay with hydrated peroxide of iron, or even mixtures of clay and substances capable of generating oxide of iron, will not be attacked by sea-water. But these experiments require a considerable time, and in the meantime it may be useful to give publicity to the results which we have obtained, as they may be useful to those engaged in the constructien of hydraulic works, and further, because it is of the greatest importance that they should be verified by experience. Whatever may be the future value which the test of experience may reserve to our inductions, two facts have at all events been well established.

1. Those cements which are reported as the best for resisting the destructive action of sea-water always contain a notable quantity of peroxide of iron.

2. Certain combinations of silica, alumina, and lime, give, under otherwise similar conditions, very different reactions, according as they are deficient in, or contain large quantities of oxide of iron.

## CEMETERY ESTATE.

SIR—As I may be accused of unduly representing the cemetery estate near the City of London and Tower Hamlets Cemetery, at Stratford, I may inform you that in a late visit I found a number of bricks and materials on one of the small plots; but whether to build a brick vault or a cellar I do not know. The cramped size of the plots makes the whole affair, and building societies generally, look ridiculous. VIATOR.

*September* 22, 1854.

## CHRIST-CHURCH, NEWGATE STREET.

It has been pointed out to us that by the removal of the houses in Newgate-street, for the purposes of widening that thoroughfare, the spire and front of Christchurch can now be advantageously seen, as well as the fine mathematical school of the time of Charles II. The latter is a good specimen of brick ornamentations, but looks dull and dingy. It will bear cleaning up. The spire of the church has a good effect, and it will be a great pity if the opportunity is lost of making part of the space available for an approach to the church, and a vista of the spire. The church is a fine one, but is now hidden; whereas, it may be made a great ornament to the street, and to an important line of thoroughfare. The plan of the church is a little askew, but from the construction of the spire, it is not so objectionable to the spectator as it might otherwise be. We hope the inhabitants of Newgate-street will press upon their constituents in the Corporation the necessity of making the improvement at once. St. Bride's was thus brought forward, to the great advantage of Fleet-street,

## PHENOMENA CONNECTED WITH THE MOTION OF LIQUIDS.*

By Professor TYNDALL.

THE lecturer commenced by referring to certain phenomena exhibited by liquids, and at variance with our commonly received notions as to their non-cohesive character. According to Donny, when the air has been, as far as possible, expelled from water by persistent boiling, such water possesses an extraordinary cohesive power, sufficient, indeed, to permit of its being heated at a temperature of 275° Fahr. without boiling. The adhesion of water, thus prepared, to the surface of a glass tube, was shown experimentally; the force being sufficient to sustain a column of water of considerable height. The contractile force of a soap-bubble was referred to, and the lecturer passed on to the exhibition of the phenomena resulting from the shock of two opposing liquid veins. In this case, though the forces are in opposite directions, motion is not annihilated; but the liquid, as first shown by Savart, spreads out so as to form a thin transparent film, the plane of which is at right angles to the direction of the jets. By varying the pressure on one side or the other, or by making the jets of different diameters, the plane film could be converted into a curved one, and sometimes actually caused to close, so as to form a pellucid sack. A vein was caused to fall vertically upon a brass disk upwards of three inches in diameter. The liquid spread laterally on all sides, and formed an umbrella-shaped pellicle of great size and beauty. With a disk of an inch in diameter a pellicle of at least equal magnitude was formed. When a candle was placed underneath the curved sheet of water, a very singular effect was produced. The film above the candle was instantly dissipated, and on moving the candle, its motion was followed by a corresponding change of the aqueous surface. On turning a suitable cock, so as to lessen the pressure, the curvature of the film became increased, until, finally, the molecular action of the water caused it to form a curve returning upon itself, and exhibiting the appearance of a large flask. When the film completely embraced the vertical stem which supported the brass disk, a change in the form of the liquid flask was observed. The latter became elongated, and was sometimes divided into two portions, one of which glided down the vertical stem and was broken at its base. When the jet was projected vertically upwards, large sheets were also obtained. The jet was also suffered to fall into small hollow cones of various apertures, and the shape of the liquid sheet received thereby some beautiful modifications. The enclosed sides of the hollow cone gave the liquid an ascending motion, which, combined with the action of gravity, caused the film to bend, and constitute a work of great beauty.

* Paper read at the Royal Institution.

## NOTES OF THE MONTH.

*Ironmongers' Estate.*—The Worshipful Company of Ironmongers, in consequence of the falling in of many leases in their valuable estate in St. Luke's, are now engaged in extensive building operations. Five houses are to be built in Brick-lane.

*Hackney Union.*—With a view to economy, the Guardians of the Hackney Union are constructing new washhouses and drying rooms.

*Hoxton Schools.*—The large schools for one thousand children, attached to the Wesleyan Chapel in the New North-road, are now in progress.

*New Tilbury.*—Sheet piling is being laid down to form a large embankment behind the railway landing-stage.

*Purfleet.*—A new bridge, road, and other works, are now being carried out on the Ordnance property at Purfleet.

*Cheshunt.*—The site of the new Cemetery has at length been agreed upon, and two chapels, entrance lodge, &c., are to be constructed.

*Newcastle-upon-Tyne.*—The Northumbrians are determined to vie with the Liverpool men. St. George's Hall is just opened, so the capital of the northern counties is to have a new town-hall, music-hall, and public offices.

*Coventry and Warwickshire Freehold Land Society.*—The society have taken active possession of their estate in the parish of St. Michael's, Coventry. Streets are being made, and footpaths paved. The estate is at Red-lane.

*Counties Permanent Building Investment and Land Society.*—The High Park estate, at Smethwick, is being laid out under the direction of Mr. Clark, of Birmingham. A new street is formed upon it, properly sewered.

*Christchurch, N.Z.*—Measures are in progress to build a new Presbyterian church in this settlement. A town-hall is likewise in progress, for which a new site has been chosen.

*Lyttelton, N.Z.*—The Wesleyans have raised subscriptions to build a chapel in this part of the Canterbury settlement. Our readers will remember that the Canterbury settlement was intended to be an exclusive Church of England settlement.

*Barbadoes.*—Bridgetown is affected by the cholera in more ways than one. It seems there are a considerable number of moveable wooden houses within the limits of the city, and the authorities have felt called upon in consequence of the death of the owners by cholera, and the attempt of other parties to move the houses from their present sites, to give notice against all such undue tampering. There is, however, a determination on the part of the authorities to improve the city altogether, for we find that the cholera infected the worst lanes of the city, and the health commissioners are determined to get the place into a more healthy state if they can. By a new ordinance just published, we see that all buildings hereafter to be erected in the city or within three hundred yards of the limits thereof, are to be made of brick or stone, or bricks and stones together, or brick nogging, except balconies and the frames of doors and windows. Barbadoes being liable to earthquakes, light building materials and low houses are nevertheless necessary.

## NEW PATENTS.

### PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAW AMENDMENT ACT.

*Dated May* 17.

1097. J. M. Rabier, Paris—Improvements in keels of ships and vessels

*Dated May* 23.

1147. L. E. Dufour, Paris—Improvements in breech-loading fire-arms

*Dated June* 20.

1349. R. Reeves, Bratton Westbury, Wilts—Improvements in drills for drilling liquid manure

*Dated June* 26.

1405. H. Mantegus, Rouen—Improvements in the manufacture of boots, shoes, goloshes, or in shoe-making generally

*Dated July* 5.

1477. T. Grubb, Dublin—Improvements in microscopes

*Dated July* 6.

1485. W. N. Nicholson, Newark—Improvements in hay-making machines, part of which improvements is applicable to carriages generally

1490. N. M. Caralli, Glasgow—Improvements in the manufacture or production of ornamental fabrics

*Dated July* 8.

1504. J. H. Johnson, Lincoln's-inn-fields—Improvements in the manufacture of carbonates of soda. (A communication)

*Dated July* 12.

1531. W. A. Gilbee, South-street, Finsbury—Improvements in the application to weaving of certain textile plants not hitherto employed, either alone or in combination with silk, cotton, and other fibrous substances. (A communication)

*Dated July* 13.

1544. R. J. Maryon, York-road, Lambeth—Improvements in the construction of, and arrangement of, and application of, steam-engines for the better means of transmitting motion, and of applying steam or other motive power

*Dated July* 18.

1575. C. M. Archer, St. James's-gardens, Haverstock-hill—Treating all kinds of paper whereon any printing, engraving, engrossing, letter-writing, or lithographing has been printed or impressed, so that the said printing, engraving, engrossed, letter-writing, or lithographing may be completely removed, discharged, or obliterated from the said paper, and so that the said paper may be readily re-used in sheets or be reconverted and worked up again into its primitive pulp by the ordinary method, and be again manufactured into and be used as paper

*Dated July* 21.

1599. Sir J. S. Lillie, Pall Mall—Improvements in fire arms

1608. R. A. Brooman, Fleet-street—Improvements in treating raw silk fabrics while being dressed and dyed. (A communication from C. Jandin and A. Duval, Lyons, France)

*Dated July* 24.

1621. R. Roberts, Manchester—Improvements in machinery for punching, drilling, and riveting

1623. A. Dastets, Paris—The extraction of a substance for supplying the place of quinine

*Dated July* 25.

1628. H. Chaumont and J. B. Bavelier, Dijon—Improvements in the manner of treating beetroot, and all other sugary and feculent vegetables

1631. A. V. Newton, Chancery-lane—Improvement in the process of converting wood into paper. (A communication)

*Dated July* 26.

1647. W. L. Tizard. Aldgate—Improvements in fermentation and in apparatus employed therein

1648. P. V. Delaye, Paris—Improvements in printing-blocks

1649. C. Luques, Boulevart St. Martin—Improved centrifugal governor

*Dated July* 28.

1664. R. H. Thompson, Old Charlton, Kent—A universal self-acting sawing machine.

*Dated July* 29.

1679. A. E. L. Bellford, Castle-street, Holborn—Improved method of engraving. (A communication)

1680. E. J. J. Dixon, Bangor—Improvements in apparatus for teaching reading and arithmetic

*Dated July* 31.

1683. J. C. D. Demay, Leicester-square—Preventing the accidents on railways with the aid of a right line of iron; and in stopping the trains almost instantaneously. (A communication from A.C. Cardot)

1687. A. V. Newton, Chancery-lane—Improved mode of extracting sulphur from compounds of india-rubber and sulphur. (A communication)

*Dated August* 3.

1704. H. Gerner, Moorgate-street—Improvements in the construction of omnibuses, parts of which are applicable to carriages generally

1706. C. Tetley, Thurlow-villas, Dulwich—Improvements in rotatory engines to be worked by steam or water

*Dated August* 4.

1708. E. Hallen, Cornwall-road, Lambeth—Improvements in chairs, chair-bedsteads, and other seats and bedsteads

1710. M. A. Dayley, London-street, Fitzroy-square—Improvements in furnaces for the purpose of consuming smoke and economising fuel

1712. E. Hamilton, Edinburgh—Improvements in the manufacture or production of beverages or occasional drinks

1714. C. W. Harrison, Richmond—Improvements in obtaining and applying electric currents, and in the treatment of certain products derived in obtaining the same, part or parts of which improvements is or are applicable to the production of motive power

*Dated August* 5.

1716. C. F. Stansbury, of the firm of Nourse and Co., Cornhill—Improvements in machinery for making rope. (A communication from W. Robinson, jun., Warsaw, New York)

1718. C. F. Stansbury, of the firm of Nourse and Co., Cornhill—Improvements in cut nail machines. (A communication from T. H. Barlow, Lexington, Kentucky)

1720. J. Cunningham, Beith, Ayr—Improvements in the preparation or production of printing surfaces

1722. J. H. Johnson, Lincoln's-inn-fields—Improvements in the manufacture of railway and other wheels. (A communication from H. U. Petin and J. M. Gaudet, Rive de Gier, France)

*Dated August* 7.

1723. G. W. Yapp, Cornhill—Improvements in steam boiler and other furnaces

1724. E. Alexandre, Paris—Improvements in concertinas

1725. G. A. Cox, Lochee, Dundee—Improvements in machinery or apparatus for winding yarns or threads

1726. J. B. T. Aubert and F. A. Cossus, Paris—Improvements in obtaining fibre from woollen rags

1727. J. H. B. Thwaites, Bristol—Improvements in apparatus to facilitate the communication by cypher

1728. J. Knight, Stamford—Improvements in engines to be worked by steam, air or other fluids or liquids

1729. E. F. Duquesne, Brussels—Improved mode of manufacturing gas for illumination

1730. S. Lucas, Dronfield Foundry, near Sheffield—Improved mode of manufacturing steel

*Dated August* 8.

1731. H. Dircks, Moorgate-street—Improvements in steam-engine boiler furnaces and other furnaces for the prevention of smoke

1732. T. Waterhouse, Sheffield—Improvements in machinery for cutting files. (A communication)

1733. H. Stoy, St. John's-road, Battersea Rise—Stopping of engines and carriages on railways, and also vehicles of every description on the common roads

1734. J. Hulme, Manchester—Improvements in apparatus for preventing the explosion of steam-boilers, for measuring the pressure of steam and other fluids, and in heating water for the supply of steam-boilers

1735. H. Turner, Leeds—Improvements in preparing hides and in cutting them into straps for driving machinery

1736. H. Moorhouse, Denton—Improvements in certain parts of machinery or apparatus used in preparing cotton, wool, or other fibrous materials to be spun

1737. C. White, Tachbrook-street, Pimlico—Improvements in printing-blocks for printing ornamental or decorative paper

1738. A. Corvi, Paris—Improvements in musical instruments

1739. A. Ogg, Glasgow—A new composition applicable to the cementing of leather.

1740. E. Webb, Worcester—Improved power loom for weaving horse-hair, and other fibrous substances where the weft or shoot is not composed of a continuous thread

1741. W. White, York Villa, Bayswater—Improvement in deodorising the contents of cesspools, privies, and also like matters in other places

*Dated August* 9.

1742. W. C. Pitt, Pimlico—Improvements in the construction of knobs and roses, used with locks, latches, and such like fastenings as are constructed with spindles. (A communication)

1743. T. Kaye, Grange Moor, York—Improvements in the means of reversing the direction of motion of steam-engines

1744. P. Oulton, Dublin—Improvements in obtaining motive power

1745. W. A. Gilbee, South-street—Improvements in hydraulic machines. (A communication)

1746. J. B. A. M. Jobard, Brussels—A new system of pump

1747. J. Lucas, Lincoln—Improved machinery for pulping or reducing vegetable substances

1748. J. Livesey, Nottingham—Improvements in the manufacture of fringes

1749. J. Hackett, Derby—Improvements in the manufacture of garments or of parts of garments, or of appendages or appliances to garments

*Dated August* 10.

1750. W. H. Clabburn, Norwich—Improvements in the manufacture of shawls and scarfs

1751. E. W. Uren, Devon—A new or improved machine and arrangements of machinery for the manufacturing of bricks, pipes, tiles, and artificial stone from clay and other plastic materials

*Dated August* 11.

1752. E. Monson, Birmingham—Improved machinery for manufacturing, cleansing, and polishing daguerreotype plates

1753. S. Bickerton, Oldham—Improved gas-light governor or regulator, which invention is also applicable to regulating the supply of water and other fluids

1754. J. Reimann and F. Sauerman, Prussia—Improvements in fire-arms

1755. P. G. Greville, Lombard-street—Improvements in the manufacture of cards for working wool and cotton. (A communication)

1757. J. Tennant, Shields Monkton, Ayr—Improvements in grubbers for agricultural purposes

1758. W. Blundell, New Broad-street, London—Improved apparatus for treating or preparing any part of the human body requiring to be surgically operated upon, for the purpose of totally or partially benumbing the sense of feeling at the desired part of the human body.

*Dated August* 12.

1759. T. Cox, Southampton-street, Strand—Improvements in stools, cushions, and hassocks

1760. J. Gibson, Paddington—Improvements in the manufacture of railway wheels

1761. T. G. Taylor, King's Arm's-yard—The use of application of the stalk of the hop plant in the manufacture of paper, pasteboard and millboard, cordage, rope, and textile fabrics

1762. W. Woodcock, Earl's-court Brewery, Brompton—Improvement in the combustion of fuel

1763. P. A. Roguier, Paris—A new mode of treating and curing varicose veins of the human body. (A communication)

1764. G. Weston, Sheffield—Improved veneering apparatus

1765. J. B. Daines, Charles-place, De Beauvoir-square—Improved mode of treating surfaces of stone, plaster, and cement, for the preservation of the same from decay

1766. J. Petrie, jun., Rochdale—Improvements in machinery for drying wool

*Dated August* 14.

1767. J. T. Stoneham, Manchester,—Improvements in the mode or method of rendering woven fabrics waterproof, and in the substance or composition used for the purpose

1768. H. L. E. D. Hennebutte, Esquermes les Lille Nord, France—Improvements in the manufacture of varnishes

1769. J. Moore, Manchester, S. Beswick, Failsworth, and B. Wilson, Woodhouses—Improvements in the manufacture of piled goods or fabrics

1770. P. Haworth, Manchester—Improved belt, band, or strap-fastener

1771. W. Todd and J. Todd, Haywood, Lancaster—Improvements in power-looms for weaving

1772. W. Crosland, Hulme, Lancaster—Improvements in machinery or apparatus for governing or regulating the speed of steam-engines, or other motive-power engines

1773. H. Smith, Smethwick—Improvements in the manufacture of wrought-iron wheels

1774. J. Beardmore, jun., Stowage, Deptford—Improvements in supplying air to furnaces

*Dated August* 15.

1775. J. Greaves and C. M. Greaves, Birmingham—Improvement or improvements in the manufacture of certain kinds of spectacle frames

1776. B. O. Stratford, Earl of Aldborough, Wicklow, Ireland—Improvements in projectiles

1777. J. Norton, Cork—Improvements in bolts and projectiles for fire-arms

1778. J. W. Taylor and C. J. Taylor, Nottingham—The employment of adhesive imitation embroidery to lace, muslin, silk, woollen, cotton, or other fabrics, such embroidery being formed of cut, pressed, or stamped patterns of velvet, crape, or other materials

*Dated August* 16.

1779. R. Caunce, Bolton-le-Moors, Lancaster—Improvements in machinery for preparing cotton and other fibrous materials

1780. J. Coupland, Southampton—The preparation and manufacture of a pulp to supersede the use of rags and similar fabrics in the manufacture of paper

1781. T. Atkins, sen., Oxford—Improvements in the mode of preparing land, constructing machinery, and other apparatus for applying and maintaining an under current arterial circulation of fluid manure, gases, vapours, and air to the seeds and roots of plants

1784. F. Higginston, King William-street City—Improvements in the mode of laying, directing, and aiming with ordnance, ship, garrison, and battering guns and field-pieces of every description.

1785. S. Frankham, Greenland-place—Improved means of consuming smoke and economising fuel in furnaces

1786. E. Carr and W. Crosby, Sheffield—Burning or consuming smoke in furnaces and fires for engine-boilers.

1787. W. Konnard, Queen-street, Holborn—Improvements in attaching door or other knobs and handles

1788. E. Manière, J. Baptiste, A. Piette, and J. F. Mermet, all of Bedford-row, Holborn—The conversion of peat into colours

1789. W. Siddons, Birmingham—Improvements in locks for guns and other fire-arms

1790. J. Lamb and T. Lamb, Kidderminster—Improvements in Jacquard machinery, and in the apparatus connected therewith

1791. E. Hamilton, Edinburgh—Improvements in the manufacture or production of beverages or occasional drinks

1792. T. Wallworth, Manchester—Improvements in purifying and treating grain, and in dressing flour, and in machinery for these purposes

1793. W. Johnson, Lincoln's-inn-fields—Improvements in furnaces and in the consumption or prevention of smoke. (A communication from E. Lambert, Troyes, France)

1794. W. Johnson, Lincoln's-inn-fields—Improvements in windlass

*Dated August* 17.

1795. C. Cowper, Southampton-buildings, Chancery-lane—Improvements in the felting of hats, and in machinery for that purpose. (A communication)

1796. J. T. Wright and E. P. Wright, Birmingham—Improvement or improvements in the manufacture of ropes, cords, lines, and twines

1797. J. Hackett, Derby—Manufacture of new and improved fabrics of cotton and of linen, and of cotton and linen combined

1798. C. Blake, St. Leonard's, Sussex—Improvement in or addition to doors, and door and window frames

1799. R. Griffiths, Strand—Improvement in the manufacture of brushes

1800. J. Bernard, Carlton-chambers, Regent-street—Improvements in the manufacture of boots and shoes, or other coverings for the feet

1801. L. C. Koeffler, Rochdale—Improvements in extracting colouring matter, also applicable for extracting size or glue from animal substances

*Dated August* 18.

1802. S. Spaldin, Hull—Improvements in apparatus for preventing loss of life at sea

1803. E. Trenery, Stourbridge, Worcester—A new or improved machine for driving piles

1804. W. Baker, Birmingham—New or improved method of manufacturing the bezils or rings used in glazing the dials of clocks and barometers, and for other like purposes

1805. J. F. Walton, Sarrat-hall, Hertford—Improvements in obtaining impressions from lithographic stones or plates

1806. J. R. Hill, Princes-street, Stamford-street — Improvements in machinery for pulverising metallic ores or other similar hard substances

1807. J. P. Clarke, Leicester—Improvements in the manufacture of reels for reeling of cotton, linen, thread, silk, or other fibrous material

1808. T. W. Rammell, Trafalgar-square—Improvements in stoves and fireplaces

1809. W. E. Newton, Chancery-lane—Improved machinery for cutting files and rasps. (A communication)

1810. A. V. Newton, Chancery-lane—Improvements in direct-acting marine engines. (A communication)

1811. J. Coney, Birmingham—Improved construction of corkscrew

1812. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in preserving corn and other dry seed. (A communication)

1813. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improved composition for fixing lithographs and engravings on canvas after being transposed or reproduced by a printing-press. (A communication)

1814. W. Ker and M. Ker, Tottenham-court-road—Improvement in the frames of expanding-tables

1816. S. Kershaw and J. Taylor, Heywood, Lancaster—Improvements in carding-engnies.

1817. E. Lund, Manchester—Improvements in cocks, valves, water-plugs, and flexible joints
1818. F. Mathieu, Bartlett's-building, Holborn—Improvements in filters
1819. W. Johnson, Lincoln's-inn-fields—Improvements in moulding or shaping articles of vulcanised caoutchouc. (A communication)
1820. W. Johnson, Lincoln's-inn-fields—Improvements in the manufacture of hat-bodies. (A communication)

*Dated August* 19.

1821. W. Fox and W. H. Fox, Compton-street, Middlesex—Improvements in furnaces to facilitate the combustion of smoke
1822. C. O'Neill, Liverpool—Improvements in the mode or method of fitting-up or fixing the berths in emigrant ships or other vessels
1824. J. Barrows, Handsworth, Stafford—A new or improved instrument to be used in cutting loaves of bread and other articles of food
1825. N. Brough, Birmingham—A new or improved dress-fastening
1826. J. Hodgson, Liverpool—Improvements in the construction of iron vessels
1827. J. Allen, and J. Taylor, North-street, Aberdeen—Improvements in the construction of rotatory engines
1828. G. T. Smartt, Doncaster—Economising the use of grease, oil, or other lubricating articles in axle-boxes
1829. G. N. Lamb, St. Helen's, Lancaster—Improvements in the manufacture of Portland cement
1830. W. V. Greenwood and J. Saxby, Brighton—Improvements in signal-lamps
1831. J. Worrall, jun., Salford—Improvements in the method of cutting fustians, cotton velvets, and other piled goods or fabrics

*Dated August* 21.

1833. T. S. Simpson, St. Anne's-place, Limehouse—Improvements in sashes
1834. T. Miller, Fairfield-place, Stepney—Improvements in apparatus for raising coals and other weights from the holds of ships and other places
1835. W. H. Smith, Philadelphia, H. Bessemer, Baxter-house, St. Pancras, and R. Longsdon, Hornsey-lane—Improvements in the manufacture and treatment of slag and vitreous substances, and the combination of other substances therewith
1836. S. T. Jones, Union-court, Old Broad-street—Improvements to reduce and wash minerals to extract metal therefrom, especially gold
1837. J. Grist, Islington—Improvements in machinery for the manufacture of casks, barrels, and other similar articles
1838. R. B. Cooley, High-street, Nottingham—Improvement in gloves

*Dated August* 22.

1840. A. Jacquelain, Paris—Improvements in the manufacture of gas for illumination and heat
1841. W. Johnson, Lincoln's-inn-fields—Improvements in the manufacture of carding apparatus for the preparation of fibrous materials. (A communication)
1842. W. H. Meriwether, Morley's Hotel, Strand—Improvements in the construction of fences and hurdles
1843. R. Benton, Saltley Hall, Birmingham—Improvements in marine and railway telegraphs
1844. J. Buchanan, Leamington Priors—Improvements in marine engines
1845. W. H. Meriwether, Morley's Hotel, Strand—Improvements in producing surfaces for lying, reclining, or sitting upon
1846. J. L. Hancock, Milford Haven—Improved pneumatic safety-inkstand
1847. W. E. Newton, Chancery-lane—Improvements in carding engines. (A communication)
1848. C. Blunt, Sydenham, Kent, and J. J. W. Watson, Wandsworth—Improved description of artificial fuel

*Dated August* 23.

1849. W. S. Smith, Charlotte-street, Fitzroy-square—Improvements in pianofortes
1851. J. Norton, Cork—An igniter or apparatus for igniting explosive and combustible materials
1853. M. Curtis, Manchester, W. H. Rhodes, Gorton, and J. Wain, Greenacres Moor, Oldham—Improvements in certain machines for spinning and doubling cotton and other fibrous substances
1854. A. B. Bérard, Paris—Improvements in the manufacture of gas coke and other products from coal, and in apparatus for that purpose
1855. P. Fairbairn and T. Greenwood, Leeds—Improvements in machinery for preparing to be spun cotton, wool, flax, silk, and other fibrous materials
1856. J. L. P. J. B. H. Bouvet, Paris—Improved suction apparatus for pumping and exhausting purposes

*Dated August* 24.

1857. H. Frost, Sheffield—…ovements in furnaces or fireplaces for steam generators and other purposes
1858. W. Brooke, Martin's-lane, Cannon-street—Consuming smoke, and condensing noxious and other gases and vapours, and converting the products thereof to valuable purposes, which now escape to the injury of animal and vegetable life
1859. J. Horrocks, Pilkington, Lancaster—Improvements in pin cops, or pin-bobbins, or spools for weaving
1860. T. Hayter, the King's Head, Southwark—Improvements in apparatus for holding straps for sharpening razors
1861. H. G. de Châteauneuf, Paris—Improvements in the process and apparatus for washing
1862. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in apparatus for illuminating. (A communication)

*Dated August* 25.

1864. R. B. Froggart, Manchester—Improvements in the mode or method of purifying, clarifying, and reducing the specific gravity of oils or fatty bodies, and also of clarifying fermented liquids with the machinery or apparatus used in the said processes
1865. J. H. Tuck, Pall Mall—Improvements in packing for pistons, piston-rods, valves, and other uses
1866. J. T. Skinner, Georgiana-street, Camden Town—Improved apparatus for rendering the shunts or points of railways self-acting, applicable also to the working of railway signals
1868. H. Bessemer, Baxter-house, Old Saint Pancras-road—Improvements in guns for throwing projectiles for naval and military purposes
1869. W. Woodcock, Earl's-court Brewery, Brompton—Improvement in the construction of furnaces

*Dated August* 26.

1870. G. Wall, Manchester—Improvements in machinery or apparatus for the manufacture of pottery
1871. H. Davey, Kent-street, Southwark—Consuming smoke in furnaces
1872. J. Gedge, Wellington-street South—Improvements in boring instruments, known as augers, bits, or gimlets. (A communication from R. Cook, U. S.)
1873. W. Smith and T. Phillips, Snow-hill, London—A new mode of constructing and connecting pipes or tubes for gas, water, or steam purposes
1874. C. M. P. de Kermoal, Paris—Improved system for preserving and transporting animal and other alimentary substances
1876. H. Francis, Strand—A machine for scutching flax, hemp, and other like fibrous material
1877. P. Fairbairn, Leeds, and R. Dempster, Bessbrook, near Newry, Armagh—Improvements in machinery for carding, drawing, and spinning tow and tow waste

*Dated August* 28.

1878. A. A. Legras, Paris—Improved apparatus for regulating the level or flow of liquids
1879. T. Carr, Liverpool—Improvements in steering apparatus
1880. R. M'Connell, Glasgow—Improvements in shutter for doors and windows
1881. J. Donovan, Church-path, Hackney—Improved mode of constructing steam boiler and other furnaces for the purpose of consuming smoke
1882. J. Kirkham, Tonbridge-place, New-road and T. N. Kirkham, Edith-grove, West Brompton—Improvements in the process of manufacturing and purifying gases for lighting and heating, and in apparatus to be employed therein
1883. G. Burch, Waltham-cross, Cheshunt—Improvements in the manufacture of pulp
1884. J. Gray, Strand-street, Liverpool—Improvements in the mariner's compass

*Dated August* 29.

1885. I. J. Machin, St. Giles-in-the-Fields—Improvements in cutting screws
1886. J. L. Hancock, Milford Haven, Pembroke—Improvements in machinery for draining land
1887. J. Burridge, Great Portland-street—Improvements in apparatus for closing fire-places
1888. J. Gray, Dublin—A self-acting flushing-apparatus, which may be arranged for registering the quantity of water or other liquid flowing through it
1889. T. McNally, William-street, Blackfriars—Improvements applicable to window-sashes or shutters
1890. L. N. Langlois and J. B. Clavières, Paris—A new mode of constructing steam-boilers
1891. J. de Redon, Paris—A new machine for cutting or preparing wood to be used in the manufacture of paper
1892. J. Seithen, Wakefield-street, Brunswick-square—Improvements in the manufacture of cases or envelopes for covering bottles
1893. J. F. Williams, Artillery-place West, Bunhill-row—Improvements in joining cast-iron tubes

*Dated August* 30.

1895. J. Mathieu, Paris—Improvements in pumps. (A communication)
1896. W. Campion, Nottingham—Improvements in the manufacture of warp fabrics
1898. W. Nimmo, Pendleton, Lancaster—Improvements in machinery or apparatus for producing ornamental woven fabrics
1900. J. Seithen, Wakefield-street, Brunswick-square—Improvements in apparatus for cutting squares of cork
1901. W. Symington, King William-street, London—Improvements in apparatus for heating air by means of steam

*Dated August* 31.

1902. M. N. Illakowicz, Maddox-street, London—Improvements in picture frames
1903. R. C. Witty, Torriano-avenue, Camden-road-villas—Improvements in illumination by means of artificial light
1905. J. Bernard, Club-chambers, Regent-street—Improvements in the manufacture of combs
1906. E. König, Rue du Temple, Paris—Improvements in manumotive carriages
1907. W. Campion, Nottingham—Improvements in rotary knitting-machinery
1908. J. M. Dunlop, Manchester—Improvements in machinery or apparatus for preparing, cleaning, and cutting india-rubber and gutta-percha. (Partly a communication)

*Dated September* 1.

1910. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improved soap, to which he gives the name of saponitoline. (A communication)
1911. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in apparatus for retarding and stopping railway carriages. (A communication)
1912. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improved process of manufacturing alcohol from the stem and ear of maize. (A communication)
1913. M. L. Lindheim, Paris—Improvements in the manufacture of bonnets and caps
1914. J. Danks, Birmingham—Improvement or improvements in inkstands, which improvement or improvements may also be applied to the stoppers of bottles, the packing of pistons, and other like purposes

*Dated September* 2.

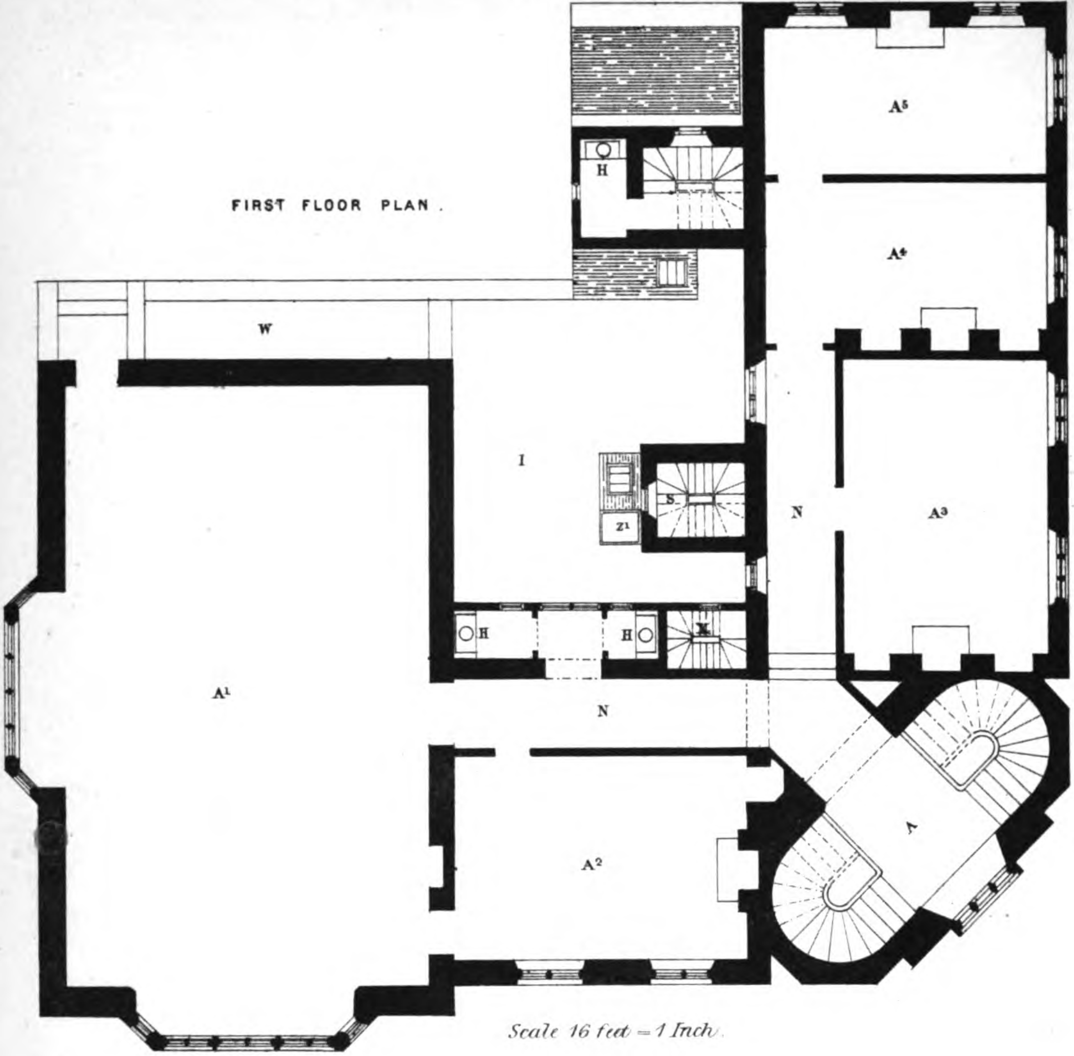
1915. J. Worthington, Manchester—Improvements in counters or fittings of shops, warehouses, and offices, for arranging, preserving, and exhibiting articles therein
1916. H. Edwards and J. Hodson, Islington—Improvements in the formation of envelopes
1917. G. Lewis, High Cross-street, St. Martin's, Liecester—Improvements in the construction of locks
1918. W. Finley, Aylesford, Kent—Improvements in machinery for manufacturing bricks and tiles
1919. H. B. Barlow, Manchester—Improvements in machinery for cleaning cotton and other fibrous materials. (A communication)
1920. N. Callan, Maynooth-college, Kildare—Improvements in certain galvanic batteries
1921. P. A. Decoster, Paris—Improvements in extracting the saccharine parts of the sugar-reeds, and of other sacchariferous substances
1922. T. Craddock, Portway Foundry, Potter's-lane, Wednesbury—Improvements in the steam-engine
1923. R. D. Kay, Accrington—Improvements in machine printing
1924. A. V. Newton, Chancery-lane—Improvements in machinery applicable to the cutting, dressing, and polishing of stone. (A communication)

*Dated September* 4.

1925. E. A. Cowper, Great George-street, Westminster—Improvements in self-feeding furnaces, and in machinery for working such furnaces
1929. J. L. White, H. Henderson, and J. Couper, sen., Glasgow—Improvements in water-closets
1931. E. Rowland and J. Rowland, Manchester—Improvements in coupling or connecting links for railway carriages or other such purposes
1933. S. Mayer and W. Bush, Bristol—Improvements in reducing flint and other substances, rendering them suitable for the manufacture of porcelain and other earthenware articles
1935. J. W. Sloughgrove and J. H. Wheatly, Windsor-street, Islington—Improvements in furnaces and ovens to promote the consumption of smoke

## PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

1823. H. Bauckham and H. Glover, Southwark, Surrey—Improvements in constructing an apparatus or instrument for securing or fastening corks or stoppers into bottles and other vessels, used to contain effervescing or other liquors, or wet or dry ingredients, and for other similar purposes—August 19
1850. T. Schwann, Neuss, Prussia—Improvements in machinery or apparatus worked or actuated by helicals or spirals—August 23
1894. P. A. de Saint Simon Sicard, Paris—Improvements in apparatus for raising and destroying submerged vessels, rocks, and other bodies, and also in apparatus to facilitate the examination of submerged bodies—August 29
1904. J. Heather, Bedford-court, Covent-garden, carrying on business under the name of W. Blackwell—An invention consisting of sugar-nippers combined with sugar-tongs to be used for the purpose of cutting or breaking lumps of loaf and crystallised sugar, and distributing the same at the tea and breakfast table, to be called "Blackwell's combined sugar-nippers and tongs"—August 31

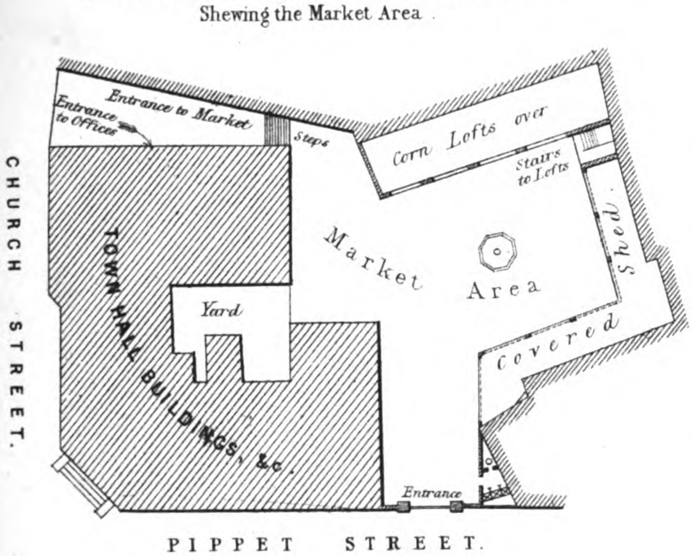



**REFERENCE**
to Ground & First Floor Plan.

A.A. *Principal Staircases.*
A1 *Large Hall.*
A2 *Committee Room.*
A3 *Mechanics Institute.*
A4 *Library.*
A5 *Reading Room.*
B.B. *Private Offices.*
C. *Clerks Office.*
D.D.D. *Cells.*
E. *Apparatus Room.*
F. *Stove.*
G.G. *Police Stairs.*
H.H.H. *Water Closets.*
I.I. *Open Yard.*
J.J.J. *Wash-Houses.*
K. *Superintendents Office.*
L.L. *Living Rooms.*
M.M. *Day Rooms.*
N.N.N.N. *Passages.*
O.O.O. *Pantries.*
P. *Shop.*
Q. *Sitting Room.*
R. *Kitchen.*
S.S.S. *Stairs.*
T.T. *Coals.*
V.V. *Sinks.*
U. *Closet.*
W. *Open Area.*
X. *Stairs to Bed Rooms of Dwelling House.*
Y. *Superintendents Stairs.*
Z. *Dust.*
Z1 *Cistern.*

*Scale 16 feet = 1 Inch.*

PLAN OF TOWN-HALL-BUILDINGS &c. BRADFORD, WILTS.
Shewing the Market Area.





*Scale 24 feet = 1 Inch.*

J. R. Jobbins

## NEW TOWN HALL AND COVERED MARKET, BRADFORD.

(*With Engravings, Plates* XXXVII. *and* XXXVIII.)

These buildings are exceedingly well situated at the corner of Church and Pippet streets, and have as commanding a frontage as could be desired, and the hill in the rear forms a most picturesque background. The design was chosen in competition; the style, which is Early Elizabethan, being thought more suitable than any other for the town of Bradford. The stone used is the red-bed, from Farleigh Down, for the dressings and ornamental work, and the Bradford freestone for the range work. The buildings are to be covered with stone-tile.

As will be seen by the plans, the buildings comprise four distinct arrangements, having no communication with each other: First, on the ground-floor, entering in Pippet-street, is the county police-station, comprising dwellings for the superintendent and two policemen, with their families, and three separate cells for prisoners, with all requisite yards and conveniences. Secondly, the principal entrance in the tower leads to the large hall, of which particulars are given below. Thirdly, in Church-street, a shop and dwelling-house. Fourthly, a suite of offices, suitable for a solicitor or public officer.

The first-floor is approached by a handsome double staircase lighted by two domes, and comprises the large assembly-hall, 50 feet by 30 feet; committee or ante room, 23 feet by 17 feet; and the three rooms forming the literary and mechanics' institute—viz., reading-room and library, each, 12 ft. 6 in. by 13 ft. 8 in.; the institute-room, 24 feet by 17 feet, with all requisite conveniences, &c.

The assembly-room will be used for the meetings of the magistrates, and for the sittings of the county-court, with the committee-room adjoining. It is lighted by two large oriel windows, and is 20 feet high to the springing of the roof (inside), which is in the form of a semi-ellipse, with moulded ribs, and boarding at the back, stained and varnished. The other rooms on this floor are 14 feet high.

On the second-floor, over the stations, are eight sleeping-apartments for the police, and over the committee-room and in tower the bedrooms to the dwelling-house. The tower is 80 feet high, covered with galvanised iron; it has two rooms in it over the staircase.

There are two entrances to the markets, the principal being in Pippet-street. They consist of an open area with covered sheds all round, and a cheese-room with corn-lofts over; a conduit and fountain is to be placed in the centre of the area.

The contracts were taken at 3000*l.*, by Messrs. Long and Spinder, of Bradford; exclusive of old materials, which were valued at about 300*l.* more, not including, however, grates, chimney-pieces, gas, or any other fittings. It is expected the buildings will be completed in the spring of next year.

## THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

***Abstract of Papers read at the Meeting held at Liverpool,* 1854.**

The scientific business of the recent meeting at Liverpool was brought to a close on Wednesday the 27th ult. The papers read in the Mechanical Section were neither so numerous nor so important as those at the meeting last year; nor were the other sections remarkable either for the novelty or interest of the matters brought before them. In point of numbers, however, the attendance at Liverpool doubled that at Hull, and the members of the Association met with a reception more cordial and hospitable than any they have experienced for some years past. Independently of the funds subscribed for the usual expenditure at the soirées, the mayor gave two entertainments—one to the most distinguished members of the Association, and another to all those who were not inhabitants of the town; and a handsome entertainment was also provided by the inhabitants of St. Helen's to about four hundred ladies and gentlemen, who joined the excursion on Thursday to see the principal manufactures of that place. Many of the people of Liverpool threw open their houses to receive the members of the Association during the time of the meeting, and the proceedings passed off with great eclat, to which the magnificent hall in which the meetings were held largely contributed.

The general committee at their last meeting recommended grants of money out of the funds of the Association, to the amount of 751*l.*, of which the sum of 500*l.* was for the Kew Observatory, and 100*l.* for Strickland's ornithological synonyms; but no part of the money was appropriated to investigations connected with mechanical science. Among the applications recommended to be made to the government was one for an early publication of the heights of ground determined by the Trigonometrical Survey; the levels of the sea which are the base of the observations; and the reasons which have guided the selection of the *places* where the sea levels were taken; also for considering the subject of navigation of iron ships; and for rendering the system of letters patent more available to the benefit of inventors.

The meeting of the Association next year will be at Glasgow, early in September, and the Duke of Argyle is appointed President.

### ON THE MEANS OF REALISING THE ADVANTAGES OF THE AIR-ENGINE.

The author, Mr. W. J. Macquorn Rankine, divides this paper into four sections. In the *first*, are explained the two fundamental laws of the mechanical action of heat, and their application to determine the efficiency of theoretically-perfect engines working between given limits of temperature; and it is shown, that as the efficiency increases with the distance between those limits, and as it is easy to employ air with safety at temperatures far exceeding that at which the pressure of steam would cease to be safe and manageable, the maximum theoretical efficiency of air-engines, consistent with safety, is much higher than that of steam-engines. For example, at the temperature of 650° Fahr., at which the air-engine has been successfully worked, the pressure of steam is 2100 lb. on the square inch; while that of air is optional, being regulated by the density at which the air is employed.

In the *second* section, the various causes of waste of heat and power in steam-engines are classified, and the actual efficiency of steam-engines is compared with their maximum theoretical efficiency, and also with the maximum actual efficiency which may reasonably be supposed to be attainable in the steam-engine by means of any probable mechanical improvements.

The following are estimates of the consumption of bituminous coal, of a specified quality, per horse-power per hour:—

1. For a theoretically-perfect engine working between such limits of temperature as are usual in steam-engines ........ ............... 1·86 lb.
2. For a double-acting steam-engine improved to the utmost probable extent .............. 2·50 lb.
3. For a well-constructed, properly-worked, ordinary, double-acting steam-engine, on an average ...................................... 4·00 lb.

In the *third* section, the causes of waste of heat and power in air-engines are classified in a manner analogous to that applied to steam-engines; and the actual efficiencies of those previous air-engines as to which satisfactory experimental data have been obtained—namely, Stirling's engine, and Ericsson's engine of 1852—are compared with the efficiencies of theoretically-perfect engines working between the same limits of temperature; the results being as follows, so far as they relate to the consumption of coal of the specified quality, per horse-power per hour:—

| | Actual Consumption. | Consumption of a theoretically-perfect engine. |
|---|---|---|
| Stirling's engine........... | 2·20 lb. | 0·73 lb. |
| Ericsson's engine of 1852 | 2·80 lb. | 0·82 lb. |

It is thus proved that an air-engine has actually been made to work successfully, and to realise an economy of fuel considerably superior to that of ordinary steam-engines; and, in fact, surpassing the utmost limit to which it is probable that the economy of double-acting steam-engines can ever be brought. Stirling's engine, as finally improved, was compact in its dimensions, easily worked, not liable to get out of order, and consumed less oil and required fewer repairs, than any steam-engine. Still the advantages shown by that engine over steam-engines were not so great as to induce practical men to overcome their natural repugnance to exchange a long-tried method for a new one. Another circumstance caused Stirling's and Ericsson's engines to meet with neglect from scientific men—namely, that both were by some persons represented as instances of *power created out of nothing*—the popular delusion commonly called "the perpetual motion."

It is shown that Stirling's air-engine, as compared with a theoretically-perfect air-engine wasted two-thirds of its fuel, and Ericsson's somewhat more.

Two obvious and powerful causes of that waste of fuel are traced—1, deficiency in extent of heating surface; 2, the communication of heat from the furnace to the working air at those periods of the stroke when it is not performing work.

The necessary conclusion is, that the more completely we remove those two causes of waste of fuel, the more clearly shall we approximate to the theoretical extent of the economy of the air-engine—an extent far exceeding that to which the economy of the steam-engine is restricted—and the more fully, in short, shall we accomplish that which has hitherto been very imperfectly done *to realise the advantages of the air-engine.*

The *fourth* section describes the improved air-engines of Messrs. James Robert Napier and W. J. Macquorn Rankine. In this engine the heating surface is increased to any required extent by means of tubes employed in a peculiar manner. The waste of heat by its communication to the air at improper periods of the stroke is prevented by a sort of plunger, or combination of plungers, called the *heat-screen*, which prevents any access of the air to the heating surface, except when it is in the act of expanding, and so performing work. The engine may be made of the same size with a steam-engine of the same power, or smaller, according to the degree of condensation at which the air is employed. The air-receivers of an experimental engine, with their various fittings, were completed some time since without practical difficulty, notwithstanding the novelty of their construction; but the erection of the engine has been retarded by delay in the execution of the cylinder, fly-wheel, shaft, and other parts, which are similar to those of a steam-engine.

Independently of the amount and value of the saving of fuel which will result from the introduction of the air-engine, it possesses the important and incontestable advantage, that even should an air-receiver burst (which is very unlikely), the explosion would be harmless, for its force would not be felt beyond the limits of the engine itself, and hot air does not scald.

## HIGH-LEVEL RAILWAY FOR THE LIVERPOOL DOCKS.

Mr. J. Grantham exhibited a model of and explained his plan for a high-level railway for the Liverpool docks, to facilitate the transit of passengers and goods along the whole line, extending at present for four miles. It is unnecessary for us to do more than mention this paper, as a detailed description was published in the *Journal* for 1853, Vol. XVI. p. 460.

## SOLIDIFICATION OF BODIES UNDER PRESSURE.

A paper was read by Mr. Fairbairn, on the solidification of bodies under great pressure, in which he stated the results of further experiments conducted by Mr. Hopkins, Mr. Joule, and himself, on the effect of pressure on melting points, and on the strength of materials. The apparatus by which the bodies operated on were submitted to pressures equal to 90,000 lb. on the square inch, was described in our notice of the meeting of the British Association last year. In the experiments reported to the Mechanical Section at this meeting, the objects kept in view had been to ascertain the exact laws which govern the cohesive strength of bodies in their natural physical conditions, and how far a knowledge of those laws may conduce to the reduction of and the subsequent solidification of the metals under circumstances whereby increased strength and density may be obtained.

The experiments commenced with spermaceti, short bars of which were cast and left to solidify, at the same temperature but under different pressures. The bar that was solidified under a pressure of 40,793 lb. carried 7·52 lb. per square inch more than one submitted to a pressure of 6421 lb.; the ratio being in favour of the more strongly compressed bar, in its power of resistance to a tensile strain, as 1 to 0·876. It appears from these experiments that bodies solidified under pressure have not only their densities greatly increased, but that their molecular structures are also materially affected so as to increase their adhesive power. Still further to elucidate the subject, cubes of exactly one inch were carefully prepared and loaded with weights till they were crushed. The first cube, solidified under a pressure of 6421 lb. was crushed with 213 lb.

Tin was then operated on. A quantity of pure tin was melted and allowed to solidify, first at the pressure of the atmosphere, and afterwards at a pressure of 908 lb. on the square inch. The same quantity taken from the same ingot was subsequently submitted to a pressure of 5698 lb. on the square inch. The bars, after having been solidified and allowed to cool for upwards of fourteen hours, were subjected to the usual tests of tensile strains. From these experiments there was derived, as nearly as possible, the same law or measure of strength as obtained from the experiments on spermaceti; for with the same pressures of 908 lb. and 5698 lb. on the square inch, the breaking weights were respectively 4053 lb. and 5737 lb.; or in the ratio of 1 to 0·706, being an increase of nearly one-third on the crytallised metal when solidified under about six times the pressure.

From these facts it is evident that the power of bodies to resist a strain is greatly increased when solidified under pressure, and Mr. Fairbairn considered it highly probable that the time is not far distant when the resisting powers of metals, as well as their densities, may be increased to such an extent as to insure not only greater security but greater economy by solidification under pressure. He said he was borne out in these views by the fact, that the specific gravities of the bodies experimented on were increased in a greater ratio to the pressure. Spermaceti, solidified under a pressure of 908 lb. on the square inch, had a specific gravity of 0·94859; whilst that solidified under a pressure of 5698 lb., had its specific gravity increased to 0·95495. The specific gravity of tin, solidified under a pressure of 908 lb., was 7·3063, and that solidified under a pressure of 5698 lb. was 7·3154, which gave ·0091 as the increased density from pressure.

There are other experiments in progress to determine the law that governs the increase of specific gravity, and to determine the conducting powers of bodies solidified under severe pressure. Experiments have also been made on clay, charcoal, and on different kinds of timber. From the experiment on powdered dry clay, it appeared that a bar of that substance 3½ inches long by 1¼ inch diameter, after being hammered into the testing cylinder so as to be slightly consolidated, was reduced in bulk, with a pressure of 9940 lb., to 2·958; with a pressure of 54,580 lb., to 2·3; with a pressure of 76,084 lb., to 2·288; and with a pressure of 97,588 lb., to 2·195 inches. Under such enormous pressures, clay and other substances operated on, had acquired the density and hardness of some of our hardest rocks.

## A MARINE BAROMETER.

The Committee of the Kew Observatory having had their attention directed to the importance of obtaining an accurate marine barometer, have, after examining several forms of those instruments, adopted one made by Mr. Adie, who thus described it:—The tube has a diameter of from 0·22 inches to 0·55 inches. About four inches of the tube, near the middle, has a capillary bore in order to produce the contraction necessary to prevent inconvenient oscillation at sea from the motion of the vessel. The degree of contraction is such that, when the barometer is first suspended, the mercury requires about twenty minutes to fall from the top of the tube to its proper level. A pipette, or Gay-Lussac's air-trap, about two inches long, is inserted a little below the contraction, which serves to prevent the entrance of air into the upper part of the tube, or into the capillary portion of it. The lower end of the tube, which is within the mercury in the cistern, is also contracted. With these precautions it is believed that when the tube has been well filled at first it is very unlikely to become deteriorated. The mercury is necessarily boiled in the tube in the process of filling. The cistern of the barometer is a cylinder of cast-iron, the tube being fitted into it mercury-tight by cement; a portion of the upper part of the cistern being covered with strong sheepskin leather firmly fixed by abutting flanges. This leather has been found to be sufficiently porous to permit the free action of the air through it, but not to allow the mercury to pass without considerable pressure, to which it can never, from the construction of the instrument, be subjected. The cistern is filled with mercury to such a height that it can never under any circumstances of temperature or pressure be full, but always sufficiently so to prevent the lower end of the tube being ever exposed either during carriage or when in use. This renders any adjustment of the instrument when being mounted for observation unnecessary. The diameter of the cistern is about 1·3 inch. The barometer tube is protected by a cylindrical case of brass, which is screwed firmly to the upper portion of the iron cistern. The graduation is made on this brass tube, and the vernier moved by a rack and pinion, the index being adjusted to the top of the mercurial column by shutting off the light, as is commonly done in standard and other good barometers; the vernier reads to 0·002 inch. The correction for the relative capacities of the tube and cistern (which is usually applied as a numerical correction varying with the height) is in these instruments included in the graduation of the scale, the scale being shortened by the amount of correction, but divided so as to represent the true measurements. The correction for capacity is obtained by computation from carefully measured diameters of the tube and cistern. The zero point of the scale is determined by comparison with a standard barometer. A thermometer, whose scale is divided on its stem, and having its bulb within the encasing brass tube, gives the temperature of the mercury. In making an observation it is only necessary to set and read off the vernier, and to note the height of the thermometer. The instrument presents much the appearance of a mountain barometer. It is suspended in gimbals from a point a little above the middle of the tube, the rack motion being close to the point of suspension, so that the hand may rest on the supporting arm. The supporting arm is flat, of hammered brass, thin enough to give the elasticity necessary to counteract sudden jars, and is equivalent to the spring gimbals usually employed, while much simpler in its construction.

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### CYLINDRICAL LENSES.

Professor Sturm, of Vienna, described a method of manufacturing cylindrical lenses, which by insuring accuracy of construction has removed the difficulty attending the use of lenses of that shape, and promises a great improvement in optical instruments. Professor Sturm observed that the superiority of the cylindrical principle is evident from the circumstance, that a perfectly cylindrical lens is free from the defects of spherical aberration, and that the opposite rectangular planes combine in forming ellipses in their intersections, and consequently show a greater precision, distinctness, and luminousness, and less contraction of dimensions; they, therefore, admit of enlarged visual angles. The cylindrical system, moreover, renders it practicable to form curves of all kinds, for instance, paraboles, hyperboles, ellipses, &c., which is impracticable in the spherical system. In the second place, the machine is so constructed that every lens, even for spectacles, is accurately centred, since the cross lines of the two planes pass through the middle, whilst the centralisation of spherical object-lenses is very difficult and imperfect. This defect arises, both in the best spherical and cylindrical lenses, from their being hitherto ground by hand; the imperfection becoming more evident in the latter than the grossest defects in the former; and this is the reason why more attention has not been paid to cylindrical lenses. In the third place he said that two cylindrical planes, intersecting each other at right angles, have the effect of neutralising the defect of spherical aberration; whilst two parallel spherical planes produce the effect of doubling the imperfection; consequently the former are much better adapted for spectacles.

The Abbé Moigno stated that cylindrical lenses were the invention of M. Chambland, a Frenchman, who had described them long since.—M. Sturm explained that he did not claim the invention of such lenses, but only of a means of accurately centering the halves of such lenses, and manufacturing them with strict correctness, which had never been before accomplished.

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### SUBMARINE TELEGRAPHS.

Several communications were made in the Physical and in the Mechanical Sections in reference to the probability of establishing electric telegraphic communication between England and America, and the difficulties attending such an undertaking. The first paper on the subject was read by Mr. John Brett, who after claiming for himself and his brother Mr. Jacob Brett, the honour of being not only the first inventors, but also the first projectors, of a submarine or oceanic telegraph, proceeded to give an account of the difficulties and prejudices they encountered in establishing the first submarine telegraph, which has now been successfully working for three years between France and England. He then explained some of the difficulties he had encountered in laying down the two submarine lines in the Mediterranean in July last,—especially in passing a depth exceeding, by 100 fathoms, what had previously been ascertained to exist on the route between Piedmont and Corsica. The depths encountered between England and France, and England and Belgium, did not exceed at their maximum 30 fathoms; whereas the submarine cable was laid down in the Mediterranean at a depth of 350 fathoms, exceeding about eight times that of the English Channel. He then explained the difficulties they encountered, when, after the line had been paid out, along the top of a submarine mountain for some miles at a depth varying from 180 to 200 fathoms, it suddenly as he believes, came to the edge of a precipice, making a total of 350 fathoms, where it ran out with frightful velocity; and had the cable been less strong the whole must, of necessity, have been lost. They were compelled to anchor by the electric cable all night, to restore the injury that had occurred; but he felicitated himself upon the experience thus gained, as it had led to many valuable suggestions necessary to successful operations in great depths. Mr. Brett explained his reasons for selecting this line to India, *viâ* Egypt, in preference to the line by the Italian peninsula, which would ever be impeded by the jealousies and restrictions of the petty States; whereas, to the shores of Africa, the Mediterranean telegraph passed through only the States of France and Sardinia, who had encouraged it by liberal guarantees, and had permitted all communications, in whatever language, to pass quite unrestricted through their States. From Africa, he stated, he had two plans in contemplation for its extension to Egypt—one, a line dropped in the Mediterranean in the shallow line near the coast, and another buried in the sand along the shore,—both of which he was satisfied might be laid secure from derangement of any kind. He concluded with a statement of the labour and attention he had given for many years in preparing for the telegraph to America, and of the depth, on the proposed line, as recently ascertained by Lieut. Maury, of the United States, with some estimates of the weight and cost; and stated that a return of 100*l.* to 150*l.* per day would give a fair interest on the necessary capital. His plan comprised several lines of communication.

Mr. Bakewell read a paper in the Mechanical Section on telegraphic communication between England and America, in which he proposed to facilitate such an undertaking by laying down a single insulated wire, sufficiently thick to be self-protective. By that means, he said, the difficulty of paying out the wire would be greatly reduced, as the wire would be comparatively flexible, and need not weigh more than half a ton per mile. Two or three ships laden with such a wire, assisted by a steamer, would be sufficient to convey it from the west coast of Ireland to the United States. The cost of 2500 miles of such wire, estimating it at 30*l.* a mile, would be 75,000*l.*, and allowing 25,000*l.* for the laying down and incidental expenses, a telegraphic communication might thus be formed between the old and the new world for 100,000*l.* A single wire telegraph, he contended, would be sufficient in the first instance, for the transmission of the intelligence between England and America; for even if no quicker instrument was used than the needle, there might be 1400 messages transmitted in twenty-four hours, and that number exceeds the amount of messages transmitted daily through all the wires of the Electric Telegraph Company. Mr. Bakewell exhibited some specimens by his copying telegraph, which, he said, transmits much more quickly than the needle instrument.

Mr. Varley explained in the Physical Section a difficulty which has within the last year been found to exist in the transmission of electric telegraph signals through submerged wires; and he stated the means he had contrived for overcoming it. The first public notice of the peculiar action of submerged wires in the transmission of an electric current was made by Professor Faraday, at the Royal Institution, where he stated that a wire coated with gutta-percha, and immersed in water, resembles in its effect an elongated Leyden jar, the gutta-percha taking the place of the glass, the wire being the inside coating, and the water the outside conducting substance. When an electric current from a powerful voltaic battery, is sent through a wire so circumstanced, a part of the charge is retained in the wire, and is not discharged until upwards of half a minute after contact has been broken. Where, therefore, a telegraphic instrument is used in which the electric current is always passing in the same direction, as in Mr. Morse's telegraph, which is extensively used in the United States, and occasionally in this country, the charge is retained in the wire, and the succeeding signals cannot be distinguished. This is particularly the case where the signals are recorded on paper by electro-chemical decomposition. The needle telegraph is not much affected by this retention of the charge, because the electric current is being continually reversed to produce contrary deflections of the needle, and the electricity in the wire is thus discharged. Availing himself of this action in the needle telegraph, Mr. Varley has constructed an apparatus for working Mr. Morse's telegraph, that overcomes the difficulty by sending reverse currents along the wire, after every signal, for the express purpose of discharging the wire. Mr. Varley stated, that in the submarine and subterranean wires between Holland, London, and Liverpool, Morse's instrument would only work at speeds too slow for commercial purposes; but that by aid of his apparatus these wires are now and have been for six months working at the required speed,—viz., twenty-five words per minute, for which three hundred alternations of current per minute are required. His apparatus, by discharging the wire and reversing the current at every move of the key, produces rapidly alternating currents through the wire, which are quite sufficient to actuate his galvanometer relay, which actuates a local battery to produce the marks. The little arm on the axis of the relay, instead of striking against a dead stop, rubs obliquely against a gold spring, filing off the little film of air which otherwise would prevent the instant completion of the local circuit. After alluding to the mechanical difficulties of laying a cable between England and America, he stated he had come to the following conclusions:—1st. If a wire could be suspended in an unbounded non-conductor or atmosphere, with no conducting body near it, the transmission of an electric current through it would be instantaneous, no matter what the length of wire. 2nd. The approach of any conducting body to this wire would (by induction) reduce the speed of the transmission. 3d. In the case of a wire coated with a non-conducting substance (such as gutta-percha) the induction decreases in the same proportion as the thickness of the coating is increased. 4th. The conducting power of a wire is in proportion to its substance, the induction in proportion to its surface. He then calculated the dimensions of a cable 3000 miles in length, which would transmit twenty-five words per minute. A copper wire one-sixth of an inch in diameter, coated with gutta-percha to the depth of nearly half an inch, would, he said, be found capable by aid of his apparatus of transmitting twenty-five words per minute, 3000 miles. To work the ordinary telegraphs the copper wire must be three-eighths of an inch in diameter, and coated with gutta-percha three-fourths of an inch, making a total diameter of about two inches.

Mr. John Brett stated that he had instituted a series of delicate experiments, with the aid of an eminent scientific gentleman, the results of which were, that they had so completely overcome the difficulty of the retention of the charge, that a working electric current might be transmitted to America through the thin wires now commonly employed in submarine cables, and equally as rapidly as at short distances.

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### APPLICATIONS OF WATER-POWER.

Mr. Armstrong read a paper on various applications of hydraulic power, referring more particularly to the hydraulic cranes at the Albert dock, and to those recently constructed upon an improved principle at the Stanley dock, Liverpool. He said he first introduced the principle at Newcastle-upon-Tyne, in 1846, and soon afterwards it was applied at the Albert dock in Liverpool. In both these instances the moving power was supplied from the town waterworks, but the variation of pressure in the pipes was found an objection. A comprehensive system of hydraulic machinery, combining the opening and closing of dock gates and sluices, with the cranage of goods, was next carried out at Grimsby new dock, where the pressure was obtained by means of a tower supporting a tank, into which water was pumped by a steam-engine. This arrangement obviated the objection arising from fluctuation of pressure, but in the natural process of improvement he was led to another method of obtaining the pressure, which had proved very efficacious, and had given a great impulse to the extension of such machinery. The apparatus used for this purpose was called an "Accumulator," and consisted of a heavily-weighted press, of large dimensions, into which water was forced by the steam-engine, and which gave out its power by the descent of the weight. The accumulator operated both as a reservoir of power and a regulator to the engine. Since the introduction of the accumulator, water-pressure machines had been applied to a great variety of purposes connected with dock and railway traffic, more particularly at the docks and railway stations in London. The details of the machinery were explained, and the general system was described as one which afforded the means of working a multiplicity of machines, intermittent in their action and extending over a large area, by means of transmitted power produced and accumulated at one central point by a steam-engine.

### PECULIAR INFLUENCE OF RAPID ROTATION.

The subject that excited most interest of any that was brought before the meeting of the Association, was M. Foucault's new mode of showing the rotation of the earth, by an instrument, called the "Gyroscope." This instrument was first exhibited and explained by M. Foucault, in French, to the Physical Section; it was afterwards shown at one of the soirées, when Dr. Tyndall explained its action in English; and it was subsequently exhibited to a select number of members in one of the committee-rooms, on which occasion Dr. Whewell acted as interpreter. The gyroscope is a ring of brass connected with a steel axis by a thinner plate of the same metal, all turned beautifully smooth, and most accurately centered and balanced; in other words, the axis is made to pass accurately through the centre of gravity, and to stand truly perpendicular to the plane of rotation of the entire mass. On this axis was a small but stout pinion which served, when the instrument was placed firmly on a small frame containing a train of wheels, turned by a handle, to give it an exceedingly rapid rotatory motion on its axis. To this frame it could be attached or detached instantly. The revolving mass was only about three inches wide, and four of the gyroscopes were mounted in frames a little differently. The first was mounted in a ring, attached to a hollow sheath, which only permitted the axle and the pinion to appear on the outside, so that it could be laid hold of, or grasped firmly in the hand, if the pinion were not touched, while the mass inside was rapidly revolving without disturbing that motion. By this modification of the gyroscope, M. Foucault afforded a sensible proof of the determination with which a revolving mass endeavours to maintain its own axis of permanent stable rotation; for upon setting it into rapid rotatory motion, and handing it round the room, each person that held it found himself forcibly resisted in any attempt to turn it round either in his fingers, to the right hand or left, or up and down, or in his hands if he swung it round. So that the idea was irresistibly suggested to the mind, that there was something living within which had a will of its own, and which always opposed attempts to change its position. The second modification presented the mass suspended in a stout ring, which was furnished with projecting axles, like the ring of the gymbal. These axles could be placed in a small frame of wood bushed with brass. This small frame, when placed on a piece of smooth board, could be turned freely round by turning the piece of board on which it rested, as long as the gyroscope was not revolving, friction being sufficient to cause the one to turn with the other; but, when the gyroscope was set rapidly revolving, the frame could not be turned by turning the board on which it rested, so determinately did it endeavour to maintain its own plane of rotation, as quite to overpower the friction. In the third modification of the gyroscope it was suspended in gymbals, so exquisitely constructed, that both the gyroscope proper and the supporting gymbals were accurately balanced so as to rest freely when placed in any position in relation to the earth. By this the author showed most strikingly the effect of any attempt to communicate revolving motion round any other axis to a mass already revolving, for, on placing the gymbals in a frame of wood while the gyroscope was not revolving, it remained quite steady; but, when thrown into rapid revolving motion, the slightest attempt to turn the frame round to the right or to the left was instantly followed by the entire gyroscope turning round in the gymbals, so as to bring its axis to coincide with the new axis endeavoured to be given it, with a life-like precision, and always so as to make its own direction of revolution be the same as that of the slightest turn imparted to it. Having thus demonstrated the necessary effect of combining one rotatory motion with another, M. Foucault then proceeded to demonstrate palpably that the earth's revolving motion affected the gyroscope in precisely a similar way. Having, by the screw adjustments, brought the gyroscope, in gymbals, to a very exact balance, it remained fixed in any position when not revolving. But, rapid rotatory motion having been communicated to the gyroscope mass, as soon as the gymbal supports were placed on the stand, the entire apparatus was seen, slowly at first, but at length more rapidly, to turn itself round, nor ever settle until the axis, on which the gyroscope was revolving, arranged itself parallel to the terrestrial axis, in such a sense as to make the direction of the revolving gyroscope be the same as that of the whole earth. He next showed that the determination with which it did this was sufficient to control the entire weight of the instrument, though that amounted to several pounds. He took the ring gyroscope from the side of the ring of which a small steel wire projected, ending in a hook, the wire coinciding with the prolongation of the axis of the gyroscope, and of course, when the ball was not made to revolve, the hook, if placed in a little agate cup at the top of a stand, would permit the instrument, by its weight, to fall instantly, as soon as the support of the hand was taken from it. But, upon imparting to it rapid rotatory motion, it stood up even beyond the horizontal position, so as to bring its axis of rotation nearly to the same inclination to the horizon as the axis of the earth, while the whole acquired a slow rotatory motion round the point of the hook; and so steady was its equilibrium while moving thus, that a string being passed under the hook and both ends brought together in the hand, the whole was lifted by the cord off the stand and carried revolving steadily about the room. Next, to show the motion of the earth sensibly, he placed the gymbal gyroscope suspended freely by a fine silk fibre in a stand with the lower steel point of its support resting in an agate cup; a long light pointer projecting from the ring carried a pointed card which passed over a graduated card arch of a circle placed concentrically with the gyroscope; upon imparting rapid rotatory motion to the gyroscope the index was seen as the earth moved to point out the relative motion of the plane of rotation exactly in the same way: the law of the motion being also the same as that of the well-known pendulum experiment. Lastly, he set the ring gyroscope in motion, and by placing a small pointed piece of brass at the end of the axle on the ring, the instrument went immediately through all the evolutions of a top on the floor, humming loudly.

### LIFE-BOATS.

Colonel Chesney read a long report on life-boats, which had been prepared by a committee appointed at the last meeting of the British Association at Hull, on which occasion there was a long discussion on the subject. A great part of the report was occupied with a statement of the number of life-boats on the coast, and of the loss of life and property by shipwrecks, which might have been in a great degree prevented if a sufficient number of well-constructed boats had been established. Since 1840 the five life-boat stations belonging to Liverpool had saved 1329 lives, and had, during the same period, saved 312 vessels. On the south coast of England, which is about 350 miles from the Land's End to the North Foreland, there are but about 15 life-boat stations. The eastern and western coasts, however, are better provided, there being 49 for the former between the Land's End and Berwick-upon-Tweed, a distance of 448 miles, and 33 boats for the latter, a distance of 700 miles; whilst the eastern coast of Scotland has but six life-boats, and the western only two. The Hebrides and Shetland Islands have not a single life-boat. There are five on the western coast of Ireland, but not one on its eastern shores; so that the Liverpool establishment for the preservation of life exceeds Scotland, and is nearly double those in Ireland. The paper then gave a numerous list of shipwrecks during the last four years. According to the casualties compiled from Lloyd's list, and laid before parliament, there had happened 1236 disasters, varying in magnitude from a total shipwreck to a slight shipwreck. Of these, 204 ships were never heard of again; 517 were driven ashore, and their cargoes totally or partially lost; 2665 cases of collision occurred, by which vessels were brought into port in a sinking state; 2295 were wrecked; 883 foundered; 679 were abandoned by their crews; 87 were burnt by accident, and 51 damaged by ice. The casualties to steam-boats during the same period of four years were—103 driven ashore, but afterwards floated again; 146 foundered; 15 burnt; 2 abandoned at sea; 1 capsized; 1 never heard of; and 7 returned to port in a sinking state. With the exception of 64 large vessels, between 700 and 1500 tons, this loss fell chiefly on the smaller vessels of 90 to 500 tons, and which were economically sailed and badly commanded. As an approximative loss, founded on the scale of four men and a boy to convey 100 tons, it would seem that the annual loss of life reported at Lloyd's averaged about 1250, the gross amount for the last four years being 4298. The tonnage, supposing the vessels to average 250 tons each, would give 100,000 tons of shipping lost, which, at 10*l.* per ton, would be 1,000,000*l.* sterling during the last four years. Colonel Chesney then invited the attention of the section to the tubular life-boat, invented by Mr. Richardson, of Aber Hirnant, Merioneth, which, he said, had already successfully encountered the sea in almost every form. The boat is formed of two tubes of tinned iron, 40 feet in length by 2½ in diameter, tapering at both ends and meeting each other. An iron frame-work, securely rivsted, unites the whole into one mass, the tubes having longitudinal bars of iron and hoops within, and iron keels running from end to end. They are divided into water-tight compartments, occupied by air-proof bags; a cork fender surrounds the whole of the fabric. The rowers and passengers are placed on a platform above the frame-work, which is surrounded by a light gunwale, the height of the rowlocks. A rope passes along under the kelson for the purpose of towing. Sliding keels are proposed to be added to render her more weatherly. She carries two lugsails, topsails, and jib; steers, rows, and sails well. Hitherto, it was stated, it had been found impossible to capsize this tubular life-boat.

### THE BOILERS OF THE ARCTIC.

Mr. Prosser read a paper on surcharged steam, in which he commented particularly on the construction of the boilers of the *Arctic*, which had just left Liverpool on its last voyage. The main object of the paper was to show that the great source of difficulty and danger in the use of steam is to be found in its high temperature rather than in its high-pressure, and that, consequently, all other things being equal, that medium which requires the highest temperature to produce a given pressure is the most difficult and dangerous. In the boilers of the *Arctic* the plan was adopted of giving additional heat to the steam after it was generated, and that plan Mr. Prosser contended is defective in principle and causes a greater consumption of fuel. To accomplish the heating of the steam a portion of it was passed through wrought-iron pipes, which were placed within the furnace of the boilers, and after being heated by coming into contact with it the steam was reunited with the other portion which had not been so heated, and then passed into the steam-chest and cylinder. The tubes of wrought iron, 5 inches in diameter externally, were placed horizontally fore and aft in each furnace, one on each side; the lower ones communicating with the upper ones by other tubes placed vertically of the same diameter, and united by malleable cast-iron elbows. The principle of using heated steam is no novelty, as it had been put in practice by Watt, and abandoned as useless. Numerous other persons had since revived the plan as new, and had endeavoured by fallacious experiments to prove its advantages; but Mr. Prosser contended there is loss, and no gain whatever, in heating the steam. He alluded particularly to the experiments and calculations which had led to the determination of introducing the "mixture" of steam and heated steam into the system of the *Arctic*. The experiments and calculations referred to are detailed in the 'Journal of the Franklin Institute' for the current year. They were compiled by Mr. Isherwood, from the notes of Mr. Martin. The experiments were intended to prove the advantages of "surcharged" over "normal steam," and of the "mixture" over both when applied to steam-engines, whether condensing or not. A very little reflection, however, would show that, if anything at all is proved, it is the exact contrary to the inferences drawn therefrom. High-pressure steam had been limited in its application by a sense of danger, but a far greater one is involved in its high temperature, and in these very experiments it is recorded that the felt covering of the steam-pipe was burned. The *Arctic* had been fitted up with sixteen double furnaces in four boilers. Each double furnace worked into one tube chamber, and had an aggregate recipient heating surface of about 1000 feet through which to transmit about 1000 degrees of heat to the water in the boiler, and thus convert it into steam. The steam heaters in each double furnace exposed about 50 feet to the direct action of the fire, and he had assumed the additional heating surface at 5 per cent. of the whole which the boilers previously had. The average pressure used was about 16 lb. above the atmosphere. The density of the steam would, therefore, be about 1-856th as compared with water, and this addition might increase the density, if applied in the ordinary way, by about 5 per cent., the corresponding increase of elasticity to which is 2 lb., or, in other words, we may calculate upon a gain of about 7 per cent. by a consumption of fuel equal to 5 per cent. only, or four tons per day, taking the ordinary present consumption at 80 tons per 24 hours. It is not, however, proposed to apply the heat thus, but to the heating of the steam. Now, as steam has but about ¼ the specific heat of water, it follows that the same amount of heat cannot be extracted by the steam, or by water, from the additional surface in the same space of time. Even in the impossible supposition of the density of the steam being the same as water, the rate of absorption can be but ¼, or equal to the specific heat of the steam, as compared with water, and requiring, therefore, the combustion of 1 ton instead of 4 tons of coal per day, that being all that the steam will take up. But the density of the steam, if taken only at 1·800 that of water, and half of the whole which is generated is made to pass through the steam heaters, it follows that the velocity must be 400 times greater than would be necessary in the case of water being substituted for the steam to be heated. Mr. Prosser said he had endeavoured to show, first, that these experiments are of no value whatever, because they meet no possible case; and, secondly, that the addition of 5 per cent. of recipient heating service to a boiler will be far more efficacious when applied in the ordinary way to the evaporation of the water and consequent increased tension of the steam, than to the heating thereof. The whole operation in either case is merely mechanical, although many have attached to it a mysterious action, a sort of mechanical catalysis, very difficult indeed to understand, and still more so to explain in any rational manner. The great advantage of using water as the medium consists in its great density as compared with its vapour; and this also, together with the enormous amount of latent heat in its vapour, is a great source of safety, as it avoids the danger attendant upon a sudden increase of heat, by absorbing it without the production of that fearful state of attenuation of the metal which the repeated overheating of it must inevitably produce, to say nothing of the diminished strength by a slight increase over the usual temperature employed in the steam heaters. Steam is instantly condensed by coming in contact with anything colder than itself, and hence arises enormous loss and waste, the avoidance of which appears to have led many to the belief that using heated steam is the proper remedy for this great defect. A remedy it certainly is, and one simple enough, but beset with difficulties and dangers which few are aware of, and far exceeding any other known method of using steam, however high-pressure it may be. In conclusion, Mr. Prosser suggested the use of high-pressure steam, worked expansively, and condensed without a vacuum, for ocean steamers. High-pressure steam, he said, is always dry when worked expansively under ordinary circumstances; and when, in addition to that, the working cylinder has a steam jacket, it is more than probable that far greater economy will be attained, without increase of danger, than by any system of "surcharged steam" it is possible to devise.

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RAILWAY BREAKS.

Mr. Edward M'Dermott read a paper on an improved method of applying breaks to railway carriages. The invention comprises an apparatus for applying any of the existing breaks to each carriage of a train, and to the means of connecting or disconnecting the same. The source of power is the insertion, below the water line, in the boiler, of an iron tube (say of one inch diameter), and closed at the end most distant from the boiler. The tube becomes filled with water, and has exactly the same pressure on every inch (say 100 lb.) of its surface as the water in the boiler itself. By the insertion of a cock in the boiler the pressure of the steam might be cut off at pleasure. The iron tube, or pipe, is made to enter at one side of a cylinder and out at the other, making the cylinder a part of the tube. Into this cylinder (which may be of 4½ inches diameter and 8 inches stroke) is fitted a solid piston or plug. The tube enters below the piston into the cylinder. The pressure from the boiler is turned on at a force of say 100 lb. to every square inch in the cylinder; and the area of the latter being 15·904, less the piston rod, there would be an effective pressure of 1500 lb. to act upon the piston. As the latter is driven upwards by the pressure, the piston-rod is elevated also, and, being connected with the levers of the ordinary break, they are at once brought into contact with the periphery of each wheel, and kept there as long as the tube remains in communication with the boiler.

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VARIATIONS OF THE COMPASS IN IRON SHIPS.

The subject of the variations of the compass caused by the mass of iron in iron ships excited great interest at the meeting, and gave rise to much animated discussion. The question was brought forward by the Rev. Dr. Scoresby in the Mechanical and in the Physical Section, and he explained the principles for which he has for some time contended. He observed that since the first promulgation of these views at the British Association in Oxford in 1847, he had to contend with either the denial or non-reception of them from the principal body of scientific men engaged in the consideration of compass adjustment and compass action in iron ships; but they were now admitted to be correct by those who had the best practical means of forming a judgment on the matter. These principles might be thus enumerated:— 1. That the magnetism of iron ships in its action on the compass, may be represented by a vertical and a horizontal iron or magnetic bar swinging round a compass. 2. That changes in the magnetic distribution and compass action in iron ships do take place. 3. That the changes take place in a ship's magnetism by change of magnetic latitude. 4. That there are influences in a ship, derived from the varieties of form and position (relatively to the compass) of particular masses of iron, which may act as natural correctives. 5. That the plan of correcting the deviation on iron ships by fixed magnets (unless in certain places or limited voyages) is unsafe, and in going to southern regions aggravates the error. 6. That the twisting of the iron materials will tend, especially in ships recently launched, to alter the magnetic action on the compass. 7. That it requires time to effect the changes in a ship's magnetic distribution, which ultimately may, in regions very distant from the place of building, be effected. The whole of the results plainly go, he believed, to the establishment of a proposition, of the accuracy of which he has long endeavoured to convince those interested in the navigation of iron ships, that the magnetism of such ships is, in all its qualities, changeable; the most enduring, or apparently fixed, being of a description changeable under severe straining and mechanical violence, which he has denominated retentive magnetism. No large changes may be expected under the following circumstances: 1. In iron ships long in use, and ordinarily pursuing the same voyage, because extreme distribution gets shaken down, as it were, in a medium or average state. 2. Great changes do not take place in the retentive magnetism (by far the greatest portion) in latitudes not farther south than the Mediterranean, because, 3, in ships trading in the channels, or east and west to America, the liability to new or unexpected changes greatly diminishes. In such cases, an intelligent captain, observing the changes, alteration, and allowances, may generally run with great confidence.

Dr. Scoresby concluded by making several suggestions for correcting the errors caused by the deviations of the compass. He recommended that a standard azimuth compass be placed on a high pedestal, where (on the Admiralty plan) a position of small deviation may be found. A compass at mast-head he believed best of all for reference, by which the great body of error will be demonstrated. The wheel-compass required for ships engaged in the home trade, or traversing mainly parallels of latitude not southward of the Mediterranean, if adjusted with magnets and pieces of iron, might not be then unsafe, where reference may always be had to the standard for verification. Care should also be taken in the selection of compasses, so as to have ample directive force. His improvements had trebled the directive force, weight for weight, of the compasses used in the navy up to 1839 or 1840.

Mr. Fairbairn said he had strong reasons for being the advocate of iron ships, and he thought they were the strongest and the best; but there was no doubt that they influenced the compass, and it was most desirable that means should be found of correcting the deviations with accuracy and certainty. He had had some experience of this effect himself, in one of the first trips made in an iron ship, having, in 1830, sailed in a small boat from Liverpool, her plates being only about the thickness of a shilling. They started in a fog from the Floating Lightship for Douglas, in the Isle of Man; but instead of finding the Isle of Man, they found themselves on the coast of Cumberland, owing to the change in the compass by the boat's attraction.

Mr. Grantham denied that there is any more danger of compass deviation in iron ships than in wooden ones; and he contended that the wrecks of the *Tayleur* and the *Birkenhead*, which had been attributed to variations of the compass, were produced by other causes, to which all ships are liable.

Mr. Towson contended that there is a variation of the compass in iron ships. He was convinced, however, that iron ships must progress, and that the existence of their mercantile marine must rest upon that progress; but they could only place them upon a proper basis by guarding against dangers, and instead of iron ships being brought into disrepute by these means, it would only place them upon that foundation which would cause them to progress in Great Britain.

Several other gentlemen spoke on the subject, and it was stated that the Admiralty had paid great attention to the subject, and the mode of adjustment they had adopted and the compasses they used were well calculated to overcome the difficulty.

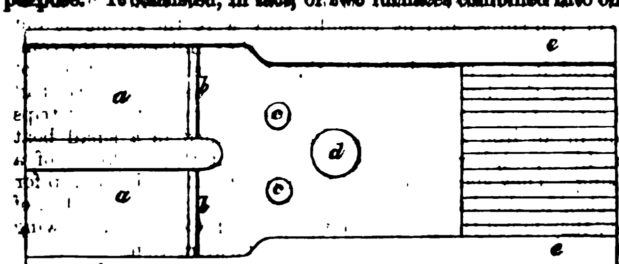
The reading of Dr. Scoresby's papers created a great sensation on the Liverpool Exchange, and he was afterwards requested to deliver a lecture on the subject in the Cotton Sale-Rooms. The rates of insurance on iron ships were raised in consequence.

### A MONSTER FLY-WHEEL.

Mr. Clay described the large fly-wheel at the Mersey Forge, which was stated to be the largest in the world. In rolling boiler plates there is a certain limit to the speed at which the roller should travel—in other words, the number of revolutions made by the roller are very few when compared with the rollers of other descriptions of iron; and it was therefore necessary in a mill where direct action was required, that a fly-wheel should be constructed of sufficient size and weight to have, with a small number of revolutions, sufficient momentum to overcome the ordinary shocks of rolling large plates of iron. This could only be done by increasing the diameter of the wheel to such an extent that the rim should have the requisite momentum. With this view a wheel has been made of 35 feet diameter, and weighing about 60 tons, about 24 tons of which is disposed in the rim, which is intended to run with a velocity of about 4500 feet per minute, in making about 38 revolutions. Great care was necessary, in a wheel of such magnitude, that the various parts should be well and securely fastened together, and after finishing the drawing of the wheel it was submitted to the authority of Mr. Fairbairn, who pronounced it as perfectly safe at a velocity of 14,000 feet per minute—number of revolutions, 120.

### THE PREVENTION OF SMOKE.

Mr. Fairbairn read a paper on the consumption of fuel and the prevention of smoke, in reference more particularly to the construction of boiler-furnaces. He said that the prevention of smoke was practicable in several ways, and it might be effected by using proper care in the furnaces at present employed without any special provision being made to accomplish that object. He referred to the Cornish engines as examples of the perfect consumption of fuel in ordinary furnaces, which is effected by the care used in feeding them, so as not to waste any fuel. If sufficient inducements existed, as in Cornwall, where the engineers are stimulated by rewards to make each pound of coal do its utmost duty, there would be no necessity for any further contrivances to be adopted; but in the absence of such stimulus, it is desirable to construct the furnaces in such a manner as to consume their smoke with ordinary management. The great secret, he said, is to have sufficient capacity in the boiler; and if boilers were made of double their usual capacity, the consumption of smoke might be readily effected. Mr. Fairbairn described a boiler-furnace which he considered to be well-adapted for the purpose. It consisted, in fact, of two furnaces combined into one.




The accompanying sketch is a plan of the furnace as shown by Mr. Fairbairn. The two fireplaces are represented by the letters *a*, *a*; *b*, *b*, are the bridges of the furnaces; *c*, *c*, are large tubes, which conduct the products of combustion into a mixing-chamber *d*, where the gases are mixed, and they then pass through the tubes *e*, *e*, perfectly transparent. The furnace-bars should be kept clean for the admission of air, and fresh air should also be admitted at the bridges to burn the inflammable gases when in a heated state, on the principle of Mr. Williams's furnace.

Dr. Arnott explained the principle on which the combustion of fuel is effected in his stoves. They are founded on the plan invented by Dr. Franklin, of inverting a fire-grate after the coals had been lighted, and thus having the coals at the bottom and the fire at the top. The smoke of bituminous coal may be regarded as evaporated pitch, and by submitting it to the action of heat in ascending through the hot coals at the top, it is completely consumed, and converted into carbonic acid gas and water. It is estimated, that in a common fire with a large open fireplace, five-sixths of the heat passes up the chimney. By contracting the throat of the chimney, the draught becomes so strong as to permit of making an opening into the chimney from the upper part of a room without the risk of its smoking, and by this arrangement a more perfect ventilation is obtained than by any other means.

Mr. Dircks explained Mr. Williams's method of consuming smoke by the admission of jets of fresh air at the bridge of the furnace. In the discussion that ensued, Mr. Jukes's plan of moveable bars was spoken of as the most effective for the purpose of consuming fuel, though difficult to be introduced in furnaces already erected.

### THE SUPPORTING POWER OF PILES.

Professor Stevelly made a communication on the limit of weight which may safely be laid on a pile driven into the ground. He said that the force which resists the penetration of a pile may, under very peculiar circumstances, diminish as the pile is driven downwards; but for the most part it increases, and generally towards the last strokes it receives from the ram the increase is very considerable. He pointed out the following simple test: viz., after the pile had been driven as deep as intended, letting the ram descend on it from a less height than the previous stroke, and carefully comparing the two distances it has been thus driven. If the resistance increase, then the actual load the pile can bear will not be less than what it would be if the resistance were strictly uniform which the pile experienced as it penetrated. This last force admits of a very simple calculation; from which, therefore, a most certain limit to the load or dead weight that can be laid on the pile without its sinking farther may be obtained. He then pointed out the two dynamic principles on which the calculation was founded:—1. When a moving mass W, strikes another W′ at rest, with the velocity $v$, then the velocity, after impact, $v' = v \dfrac{W}{W + W'}$. 2. When a body moving with the velocity $v'$, is stopped by a uniformly acting resistance, that resistance can be compared with the weight that gives the velocity (say to the ram), by the principle that the force or resistance is proportional to the square of the velocity gained or destroyed, divided by the space through which the force acts to give or take it away. The following practical rule is, then, a simple algebraic deduction from these two principles. Let W denote the weight of the ram in tons; W′ the weight of the pile in tons and decimals; $h$ the height in feet and decimals from which the ram is let fall on the final stroke; $d$ the depth in decimals of a foot which the last stroke causes the pile to penetrate. L, the limit of load (in tons) that may with safety be laid on the pile, will then be:

$$L = W \cdot \left(\frac{W}{W + W'}\right) \cdot \left(\frac{h}{d}\right);$$

in which W, W′, $h$ and $d$, can all be had by actual weighing and measurement.

### RAILWAY SIGNALS FROM CHINA.

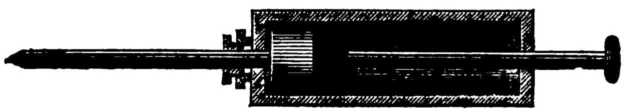
Captain J. Norton described some methods of establishing communication between the guard of a railway train and the engine-driver, one of which he exhibited that had been brought from China, and used there as a signal for different purposes. It consisted of a metal whistle fixed to a short stick, which when thrown through the air made a shrill sound. The faster it is propelled, the louder the noise; and Captain Norton said the most effective way of using it for a railway signal is to push the stick into the barrel of a pistol charged with gunpowder, and to fire it over the engine-driver's head. In this manner he had on several occasions tried its efficacy, for when the train was going at full speed he had sent the missile whistling through the air, and obtained an immediate response from the steam whistle, indicating that the engine-driver had heard it.

### STRENGTHENING CAST-IRON BY MELTING.

Mr. Oldham communicated the results of some experiments on the transverse strain on cast-iron, in confirmation of Mr. Fairbairn's experiments on the additional strength gained by re-heating, as reported at the last meeting of the Association. In these experiments, which were made on bars 2 feet long, the maximum degree of strength was attained at the nineteenth melting.

### BORING ROCKS HORIZONTALLY FOR BLASTING.

Mr. J. Nasmyth described a method of boring holes in rocks for tunnelling purposes. In the ordinary method of boring holes for blasting, by striking at the end of the bar with heavy hammers a great portion of the effect is lost by what is commonly termed the "inertia" of the bar. To overcome this defect, Mr. Nasmyth proposes to convert the bar into a piston-rod, to work in an air-tight cylinder through a stuffing-box. By this means, when the piston is drawn to the end of the cylinder, the pressure of the atmosphere will force it back again with accumulating velocity, and the blow struck will have much greater effect. Mechanical contrivances might be introduced for changing the shape and the directions of the penetrating point. The bar could be drawn to the end of the cylinder by any convenient application of mechanical power.



The annexed woodcut represents the form of the boring-apparatus, as sketched by Mr. Nasmyth.

It was suggested in the discussion that ensued, that a similar effect might be more readily produced by the employment of vulcanised india-rubber springs. Mr. Nasmyth observed, that any elastic medium would answer the purpose, but air suggested itself as affording greater extent of spring.

## FONDES' ROTARY DREDGER.*

This machine consists of a hull of suitable size to carry the machinery. In the middle of the boat athwartships, and near the bow running fore and aft, there is a well-hole about 3 feet wide and 26 feet long. In this hole works a wheel carrying upon its periphery the buckets or scoops, made in the usual manner with a hinged bottom secured with a latch. The wheel has two hubs and two sets of arms, stiffened with diagonal braces to prevent lateral motion; upon each side of the wheel is a segment spur-wheel into which is geared the pinions driven by the engines.

The journals of the scoop-wheel-shaft work in boxes that can be raised or lowered, by a chain and windlass, to suit the depth of the bottom to be operated upon. In a frame at the bow of the boat there are two hinged schutes, one of which, when the machine is in operation, is kept at one inclination; the other, situated above and leading into the first, to which it is hinged, is raised by each bucket as it passes upward; as the wheel revolves, the bucket passes beyond the reach of the schute where the end next the wheel falls beneath the bucket, striking a trigger that open its bottom, leaving the contents free to fall into the schutes, and be conveyed by them into the transporting scows alongside.

The machine, for some kinds of work, must supersede all others where a long stretch can be had, such as a bar of a river, the bottom of a canal, &c., the performance must be admirable. No time is lost, except that spent in replacing the loaded scows with empty ones, and that, by practice, may be reduced to almost nothing. As the material is cut away, the boat is drawn forward by a rope anchored ahead, and passing round a barrel on the wheel shaft; the rate of progress for each kind of cutting being regulated by the proper sized windlass barrel-wheel, can be quickly taken off and replaced by another.

It is said that a machine of the third class, having a wheel 24 feet in diameter with four buckets, has dug 1200 cubic yards of gravel bottom in a day.

* From the 'Journal of the Franklin Institute.'

## COMPUTED TABLE OF DRAUGHT OF FLUES.*

By Prof. John C. Cresson, C.E.

Having occasion, recently, to prepare a tabulated statement of the effective power of vertical flues under the influence of various conditions of temperature, I have thought it might be made useful to others by publication in the *Journal*, and therefore offer it as a small contribution to the much-neglected arts of warming and ventilation.

The numbers at the head of each column represent the temperature, in degrees of Fahr., of the air within the flue; and those in the first column on the left, that of the air outside. The calculations are made according to the following commonly received formulæ for the expansion, equilibrium, and flow of æriform bodies.

1. Gay Lussac's law showing their increase of volume to be $\frac{375}{1000}$ or $\frac{3}{8}$ in passing from freezing to boiling points of water with equal increments of volume for equal additions of thermometric heat.

2. Fluid columns are in equilibrium when their heights are inversely as their densities, or, in case of homogeneous gases, directly as their relative expansion by heat; and this difference of height, or when heights are equal, their reciprocal densities constitute the effective head creating the draught of flues.

3. By Torricelli's formula, the velocity of flow under the ascertained head is $V = \sqrt{2\,g\,H}$, and the coefficient of actual discharge is assumed as that for a thin plate, which well represents an ordinary damper or flue register, $Q = 0{\cdot}625\ A\,V$, or $\frac{5}{8}$ths the theoretical discharge.

The numbers in the body of the table show the quantity of air in cubic feet per minute that will be drawn through a register, or other similar opening 1 foot square, by a vertical flue of 100 feet effective height at the given temperatures. To adapt these numbers to flues of different heights, multiply them by one-tenth the square root of the effective height in feet.

It is to be understood that the area of cross-section of the flue is not less than that of all the openings for which the flow is computed; otherwise the computations must be based on its area instead of theirs.

| Fahr. | 60° | 80° | 100° | 120° | 150° | 200° | 250° | 300° | 450° |
|---|---|---|---|---|---|---|---|---|---|
| 0° | 1020 | 1167 | 1281 | 1380 | 1500 | 1665 | 1796 | 1896 | 2124 |
| 10 | 940 | 1092 | 1215 | 1320 | 1450 | 1622 | 1760 | 1866 | 2100 |
| 20 | 840 | 1010 | 1145 | 1256 | 1395 | 1580 | 1725 | 1833 | 2075 |
| 32 | 705 | 904 | 1046 | 1181 | 1342 | 1580 | 1675 | 1795 | 2045 |
| 40 | 594 | 826 | 995 | 1125 | 1285 | 1490 | 1645 | 1765 | 2027 |
| 50 | 426 | 723 | 904 | 1054 | 1225 | 1441 | 1606 | 1758 | 2002 |
| 60 | 0 | 581 | 810 | 975 | 1163 | 1394 | 1566 | 1697 | 1980 |
| 70 | — | 415 | 699 | 892 | 1095 | 1342 | 1525 | 1661 | 1950 |
| 80 | — | 0 | 575 | 798 | 1025 | 1291 | 1480 | 1625 | 1925 |
| 90 | — | — | 416 | 688 | 950 | 1238 | 1436 | 1590 | 1900 |
| 100 | — | — | 0 | 562 | 866 | 1178 | 1391 | 1559 | 1874 |

The small table appended below gives the proper factors to be applied as above, for flues less than 100 feet high:—

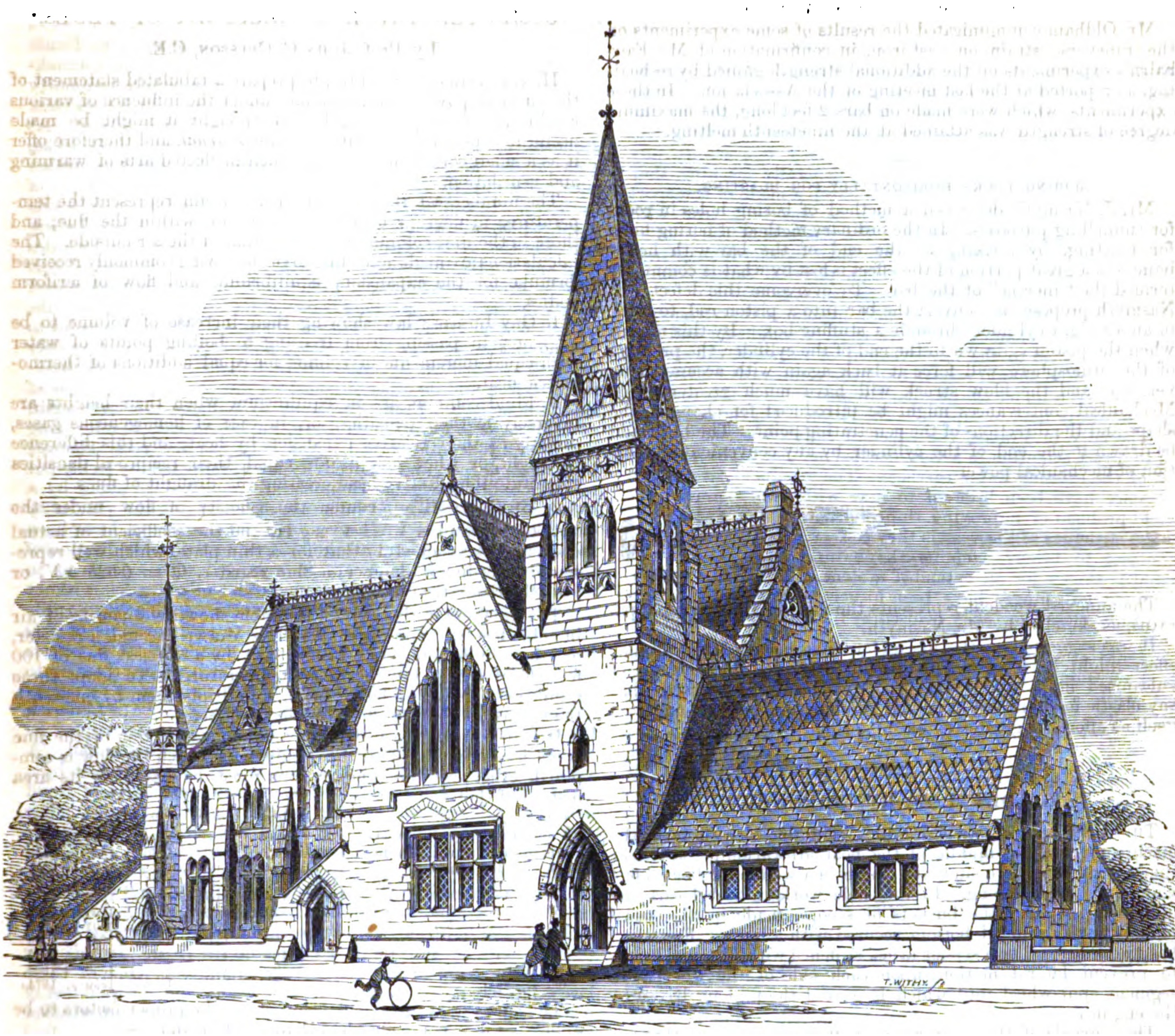
| Height of Flue. | Factor. | Height of Flue. | Factor. |
|---|---|---|---|
| 10 feet | 0·316 | 60 feet | 0·774 |
| 20 " | 0·447 | 70 " | 0·836 |
| 30 " | 0·547 | 80 " | 0·894 |
| 40 " | 0·632 | 90 " | 0·948 |
| 50 " | 0·7 | | |

* From the 'Journal of the Franklin Institute.'

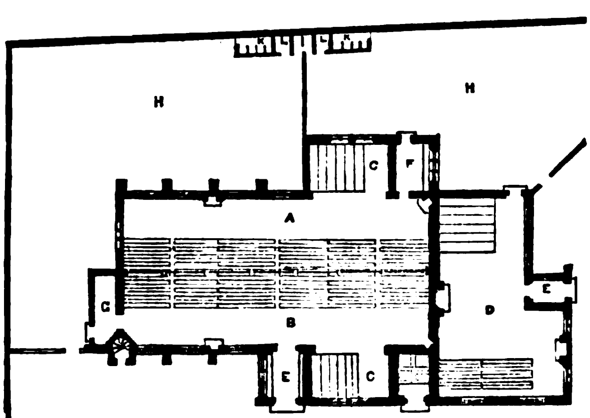
## TRINITY NATIONAL SCHOOLS, COVENTRY.

James Murray, Esq., *Architect.*

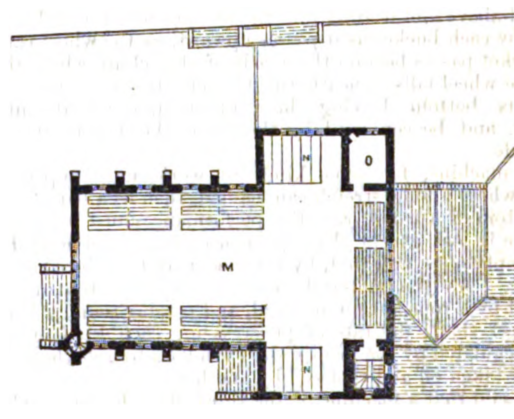
These Schools have just been completed in one of the improving districts of Coventry, to meet the want which has long been felt in connection with the mother Church. The architect is Mr. Murray, who has produced a picturesque building, and well suited to its purpose. It consists, as will be seen, of two floors, providing large boys', girls', and infants' school-rooms, with convenient class and cloak rooms. The walling is of the red sandstone of the locality, brought to a tooled surface, and irregularly jointed. The roofs are of high pitch, and are open as much as possible in the rooms. The design has been carried out by Mr. Thomas Pratt, of Coventry, at a cost of about 3000*l.* Convenient teachers' residences are immediately adjoining.



TRINITY NATIONAL SCHOOLS, COVENTRY.—James Murray, Esq., *Architect.*



GROUND PLAN.



UPPER FLOOR PLAN.

A. Girls' School
B. Boys' School
C, C. Class Rooms
D. Infant School
E, E. Porches
F. Porch and Cloak Room
G. Cap Room
H, H. Playground
I. Ashpit
K, K. Water Closets
L, L. Coal Cellars
M. School-rooms.
N, N. Class Rooms
O. Cloak Room.

## ON THE INLAND NAVIGATION OF IRELAND.*

By H. Hennessy, M.R.I.A.

Public attention has been so much directed of late years to railways as furnishing the most important channels of internal communication, that the more simple means afforded by the physical structure of our country seem to have been forgotten. Railways are undoubtedly superior in many respects to any other system of inland conveyance; but, generally speaking, they can never be considered as forming so cheap a mode of transport as water carriage. This proposition is especially true with reference to Ireland, where most of the products of the country are such as to require economy rather than extraordinary speed in their conveyance, and where certain physical causes seem to present great facilities for lines of water communication.

But if, while the most recent and ingenious contrivances of engineering or mechanical skill are eagerly sought for and systematically applied to the improvement of railways, the state of inland navigation should receive but little comparative attention, the former, even under the peculiar circumstances of this country, would naturally tend to supersede the latter. On the continent, and especially in France, the effect of railways seems to have been to direct attention in a very decided manner to the improvement of the existing water carriage. The results of science and experience have been brought to bear with fresh vigour on the twofold problem of improving the condition of the water ways and the structure of the vessels they convey. In these notes it is my object to briefly examine the natural advantages which Ireland possesses for an extended system of inland navigation, how these advantages have been hitherto availed of, and how they can be more effectually utilised by the aid of recent improvements.

A glance at a good physical map of Ireland shows it to be almost surrounded at its coasts by ranges of high hills or mountains, while a flat district of considerable extent occupies the centre. The principal groups of mountains thus situated are six in number: 1, that on the north-west, occupying the counties of Donegal and Derry; 2, that of the west, stretching through Connemara in Galway and Mayo; 3, that of the south-west, in Kerry and Cork; 4, that of the south, in Waterford; 5, that of the east, in Wicklow and Wexford; 6, that of the north-east, in Down. In the central district there is only one group at all comparable in height and extent with any of these; it lies close to the Shannon, in King's County and Tipperary. The great number of lakes with which the central district of Ireland is covered, and the considerable length of some of her rivers, seem to be natural results of this peculiar configuration. These lakes and rivers are capable of being arranged in several principal lines, some independent and others branching from them. Thus we have:—

1. The line of the Shannon, from Lough Allen to its mouth.
2. The line of the Connaught lakes, running from north to south, comprehending Loughs Con, Cullin, Carra, Mask, and Corrib, between the bays of Killala and Galway.
3. The line from Coleraine, through the Lower Bann, Lough Neagh, the Blackwater, and the lakes of Cavan and Fermanagh, towards the Shannon.
4. An offset from this line, through Lough Erne, towards Ballyshannon.
5. The Foyle and its tidal estuary.
6. The district of the Upper Bann, between Lough Neagh and Newry.
7. The important lines depending on the Shannon, namely, the Boyle water and Lough Key, the rivers Suck and Inny.
8. The Boyne in its course through Meath.
9. The Barrow through Carlow and Wexford.
10. The Suir in its course through Tipperary and Waterford.
11. The Blackwater from Mallow to Youghal.

The Shannon, with the lines of water-way immediately dependent on it, forms by far the most important of these groups. This river may be said, for the purposes we have here in view, to rise from Lough Allen, a navigable basin, 8 miles long from north to south, and on the average 3 miles broad from east to west. This lake is 160 feet above the level of the sea, and possesses a mean depth of 12 feet. It is situated in a district known for its mineral riches, as yet almost unavailable, partly from want of cheap means of transport.

* From the 'Dublin Monthly Journal of Industrial Progress.'

The following is a brief summary of the present condition of the Shannon from Lough Allen to Limerick. A canal extends from the north end of Lough Allen, at Drumshanbo, to Battle Bridge, with two locks, each of 10 feet fall. Thence to Carrick-on-Shannon, a distance of 17 miles from the northern extremity of Lough Allen, the river shoals in some places. At Knockvicar is a lock and weir in connection with the Boyle Water. At Jamestown, Roosky, and Termonbarry, there are three locks, each 120 feet long by 30 feet wide within the chambers, which effectually obviate the influence of the rapids in this portion of the river. In connection with the lock at Jamestown is a side canal, which allows of vessels of 30 feet beam. Below Lanesborough the river expands so as to form Lough Ree, 18 miles long and 3 miles in average breadth. At the south end of this Lough, close to Athlone, a lock has been recently constructed with 7 feet fall, 170 feet long between its upper and lower sills, and 40 feet in breadth within the chamber. From this point to Portumna the river is broad, deep, and sluggish, requiring only one lock at Meelick, 22 miles above Killaloe. This lock has fall of 8 feet, and its other dimensions are the same as those of the Athlone lock. From Portumna to Killaloe the river again expands so as to form Lough Derg, an inland sea, 23 miles long and from 2 to 9 miles broad. Not only has the river channel been made deeper, and its declivity been graduated by locks, but its more easily navigable channels are indicated all along by a series of beacons placed at intervals, depending on the proximity of rocks or shoals. Wharves and landing-places have been recently constructed, and all the bridges on the upper division of the river beyond Killaloe are so arranged with swivels as to allow of the passage of large steamers and other vessels without any displacement of their masts or funnels. In this way 85 miles of navigation above Killaloe are open to steam vessels of 200 horse-power and 150 feet long, while a smaller class of vessels can traverse nearly all the remaining portion of the river up to the northern extremity of Lough Allen, thus opening up nearly 160 miles of direct steam navigation. From Killaloe to Limerick the river has a fall of 97 feet in 15 miles, and is interrupted by rapids and cascades, chiefly at Doonass and Castle Connell. A very imperfect continuation of the navigation is formed by a canal, on which there are 10 locks, of such dimensions as would admit only barges of the size generally used on canals. The advantages thus presented for steam navigation on the Middle and Upper Shannon have been availed of by the City of Dublin Steam Company and by the proprietors of the Grand Canal. Steamers of large size, for the conveyance of goods and passengers have been established by the former company, and run between Athlone and Killaloe; while the latter have introduced steam power chiefly for towing their barges on the river. In this way 5 or 6 tug steamers are continually employed. One of these boats has 50 horses' power, 15 feet beam, and draws 6 feet of water, being thus well qualified to contend against rough weather on the lakes. I have been informed that the company find small boats with powerful engines the most economical for the towing work, and accordingly most of their boats are little more than floating engine houses.

An estuary navigation of 44 miles extends on the Lower Shannon from Limerick to Kilrush; and steamers with a considerable draught of water are admissable. It has been navigated for several years by boats equally adapted for sea or river traffic, belonging to the City of Dublin Steam Packet Company.

The group of Connaught lakes already mentioned might perhaps with some difficulty be converted into a complete line of navigation, extending from Galway to the bay of Killala; but there seems no doubt as to the practicability of forming two distinct lines, one connected with the former, the other with the latter of these arms of the sea. It has been estimated that the southern group, consisting of Loughs Mask, Corrib, and Carra, would require only 3 miles of canal to bring them into communication with the sea and with each other, thus opening a line of navigation at least 40 miles in length. Some progress has been made in the works for connecting Lough Corrib with Galway, but this line of navigation must still be considered as comparatively unopened.

The northern group of Connaught lakes, when properly connected by artificial works, would give a navigable line of 11 miles.

The third line of inland navigation, which has been indicated as extending from Coleraine along the Lower Bann, through Lough Neagh, the river Blackwater, and the lake district of south-western Ulster, towards the Shannon, forms with that river a great system of internal water communication, running nearly in the direction of the longest diameter of the island, from north-east to south-west. It acquires additional importance from its situation in the midst of a populous and industrious division of the country, and it is therefore satisfactory to find that much information can be supplied regarding portions of it from the valuable report drawn up by Mr. MacMahon on the drainage of the Lough Neagh district. The Lower Bann is intersected by trap dykes at certain points, by which steep rapids are produced. The first is at 7 miles from the sea, and the difference of level in the stream above and below it is from 4 to 4½ feet. From this point the water has a depth for some distance averaging 12 feet, the least depth being 9 feet, but it shoals farther on to 3 feet. From Loughan's Island to Gill's Ferry the water varies from 6 to 14 feet in depth. A few miles above this place there are two shoals, having an average depth of 4 ft. 6 in. Nine miles beyond the first rapid is another combined with a shoal having a depth of from 2½ to 3 feet, and an ascent of 8¼ feet. After these shoals come a series of rapids, with 10½ feet ascent in summer, and a depth of stream between 2 and 3 feet. Beyond these rapids the river takes a serpentine course, and is of great depth, to the foot of the Portna rapids, which are the most considerable on its course. These extend for at least a mile; but what are called the falls of Portna do not occupy more than half-a-mile of the bed of the river. During low summer water the total ascent is 18 feet. The acclivity is divided into numerous irregular tables or steps, characteristic of the trap dykes. The stream runs with great force and velocity, and the deepest of the tortuous channels in which it flows are so intricate as to make it dangerous and difficult to guide even a fishing boat through their manifold windings. From Portna, for a distance of 5 miles, to a place called Portglenone, the river has a depth averaging 20 feet, the least depth being fully 16 feet. Above this place shoals occasionally alternate with deep water. The former are usually covered with water to the depth of from to 4½ feet, and in the deep places the depth ranges from 17 to 45 feet. This occurs in one instance for the distance of 8½ miles, but the average depth seems to be from 10 to 20 feet. At the point where the river commences from Lough Beg a sand bank acts as a bar to the down stream entrance of the Lough. This Lough extends 3½ miles in the direction of the sailing course, and is about 1 mile broad. At its entrance is a new cut from 12 to 17 feet deep, and from 120 to 130 broad. There are four bridges on the Bann between Lough Beg and the sea, and another bridge between Lough Neagh and Lough Beg. At the entrance of Lough Neagh is a sand-bank, forming a bar which extends about a mile into the lake. It is 1700 feet wide at the entrance, and in summer is covered to a depth of only 18 inches, except in a narrow channel at the eastern side. The greatest accumulation of sand and gravel is principally on the western side of the Lough, from the debris brought down by the river Moyola.

Lough Neagh, the largest lake in Great Britain or Ireland, extends 17 miles in greatest length from north to south, and 10 miles in average breadth from east to west. Its dimensions as regards direct navigation are thus scarcely of greater importance than those of some of the Shannon lakes. It presents, together with Lough Beg, a surface of 101,379 acres; exclusive of Lough Beg, its surface is 98,235 acres. It is 44 feet above the level of the sea, and in some parts is 100 feet in depth. It presents more than 100 miles of coast belonging to the counties of Antrim, Down, Armagh, and Derry, and it receives from the rivers Blackwater, Upper Bann, Ballinderry, and Moyola, the drainage waters of 1835 square miles of country. The Lough has been already navigated by steam vessels, which have been enabled to touch at different points around its extensive coast.

The river Blackwater is easily navigable between Lough Neagh and Charlemont, for it rises only 2 inches, and its channel is both wide and deep. Maghery Cut, at the opening where there is a bar, allows the passage of large boats in summer. The Ulster Canal, with a course of 48 miles, connects this river with upper Lough Erne, and Lough Oughter. The aggregate coast lines of this lake and both of the Erne lakes amount to 303 miles. They contain many islands, but present no insuperable difficulties to the transit of moderately large steam vessels. Between Lough Oughter and the Shannon is a group of small lakes, which it is proposed to connect, so as to complete the line of inland navigation, extending from the coasts of Clare and Kerry to those of Derry and Antrim.

The lower Lough Erne, being 150 feet above the level of the sea at Ballyshannon, seems to be almost cut off from any practically direct communication with the sea; but there can be no doubt that great advantages would arise to the surrounding districts by its forming a branch of communication from the nearest accessible point on the coast and the great line which has been just described.

The Foyle is navigable for a few miles of its course, and in connection with the tidal Lough into which it flows may yet form an important line of water communication for portions of Derry, Donegal, and Tyrone.

Between Lough Neagh and the Irish Channel at Newry, a line of water communication exists in the district of the Upper Bann. This river is an expansion or arm of Lough Neagh, for a distance of nearly 12 miles, from the Bannwater foot to the White Coast point, where it meets the Newry Canal. It contains a few easily removeable shoals, on which there is a depth of from 2 to 4 feet in summer, and is otherwise well adapted for the application of steam vessels. The canal to Newry is 19 miles long, thus making a line of more than 30 miles of navigation between the tidal estuary of that port and Lough Neagh.

The Boyle Water is a kind of expansion or arm of the Shannon running to the north-west, and is sufficiently deep for steam navigation. It brings a large portion of Sligo and Roscommon into direct communication with the great central line of water-carriage.

The Suck, which flows through Roscommon, and enters the Shannon at Shannon Harbour, and the Inny, which rises among the lakes Cavan and Westmeath, and falls into Lough Ree, are both eminently capable of being used for internal communication. They are free from rapids, sluggish, and comparatively deep. A report on the former of these rivers has been drawn up by Mr. Rhodes, in which it has been clearly shown that its improvement for the purposes of navigation could be effected at a moderate expense.

The Boyne, flowing for the most part through the flat and fertile county of Meath, seems to posses valuable conditions for a channel of internal traffic. In its sluggish course there seems to be few or scarcely any rapids, and its shoals are, no doubt, easily removeable. About twenty-two miles have been already rendered navigable, including the tidal estuary below the port of Drogheda, and there appears to be no serious physical cause to prevent more of it from being used as a channel for commercial intercourse.

The Barrow, running nearly in the direction of the meridian, offers an important line of water-carriage for the counties of Kildare, Carlow, and Wexford. The locks which are used to overcome the declivities of this river are 60 feet long by 13 feet wide in their chambers, and are thus capable of admitting barges, or even small screw steamers, carrying a considerable cargo. Its tidal estuary is extensive, reaching from Waterford up to St. Mullins, and the portion between the former place and New Ross has been navigated by steamers. Combined with the navigable part of the Nore, it brings a part of the county of Kilkenny in contact with the sea, and its connection with the Athy branch of the Grand Canal opens a complete water communication between Waterford and Dublin.

Some of the most fertile portions of Tipperary are traversed by the winding course of the Suir, and the most thriving towns of that county are situated on its banks. It does not seem to present any insuperable difficulties to the introduction of suitably constructed steamers on a portion of its course, although as yet it has been availed of for ordinary canal barges only between Clonmel and Waterford.

The most considerable river in Munster is the Blackwater, draining a basin of more than 1200 square miles, partly in the counties of Kerry, Limerick, Cork, and Waterford. The greatest annual fall of rain being in this part of Ireland, the Blackwater delivers a considerable volume of water into the sea at Youghal, and the rapidity of the portions of its course, rather than an insufficient supply of water, would seem to be the principal obstacle to its forming a complete line of inland navigation from Mallow, or even Newmarket to the sea. The question of its improvement acquires additional importance since it has been crossed at Mallow, by the Great Southern and Western Railway, and it is to be hoped that the enterprising attempts made some years ago to establish steam navigation on a portion of it will be again revived with fresh vigour.

Although the navigation of the tidal estuary of the Lee can scarcely be considered as coming within the scope of this essay, it deserves to be noticed, as its excellent management may well serve as a model. There are at present seven steamers employed for passenger traffic, on the estuary between Cork and the sea, all capable of traversing their course at any time of tide, of which four belong to the Cork and Passage Railway Company, and three to the River Steamers Company. The boats in use present very favourable specimens of the types of steam-boat building of the Thames and Clyde, respectively, but there is good reason to hope that for the future such vessels can be equally well obtained on the banks of the Lee itself. By means of these boats an extensive daily traffic is carried on between Cork and five points on the shores of its harbour and tidal estuary, and it is intended to bring two more in a short time within the circle of their operations. The great success of these boats is, undoubtedly, attributable to their very moderate fares, as well as to their speed and excellent accommodation for passengers.

The foregoing sketch of the natural advantages possessed by Ireland for inland navigation, and the extent to which its rivers and lakes are now available for that purpose, naturally leads us to inquire when, and in what manner, attempts to form systems of water-carriage were made in this country? To give a satisfactory answer to such an inquiry, it will be necessary to glance at the history not only of river improvements, but of artificial canals; a task which is much facilitated by a paper drawn up by Mr. Nimmo, and subsequently published by Mr. Wye Williams. The remarkable preponderance of the number of projects planned over those actually executed, forms a curious comment on the political and social condition of this country.

In the first parliament of Anne, in 1703 a committee was appointed to draw up a bill for rendering the Shannon navigable from Jamestown, in the County Leitrim, to its tidal estuary at Limerick; also for opening a line of water communication between Newry and Lough Neagh, and for improving the Boyne and Barrow.

In 1709 a bill was brought in for the navigation of the Shannon, and for the Newry Canal. A petition was presented in the same year for making the Suir navigable between Thurles and Clonmel, and also to effect certain improvements on the Barrow.

In 1715, some enterprising projectors having undertaken to make the Shannon navigable, a general act was passed for the consolidation of all similar untertakings. This remarkable act is entitled, "For the draining and improving the Bogs and unprofitable Low Grounds, and for easing and despatching the inland carriage and conveyance of goods from one part to another within the kingdom."

The members of Parliament with others were declared commissioners, with powers under this act to appoint competent persons to execute the works, and the following groups of improvements in river navigation, or of entirely artificial canals, were successively contemplated and partly commenced.

1. A line from Dublin by the rivers Liffey, Rye, Boyne, Mungagh, and Brusna, to Banagher on the Shannon. The district which this line was to traverse has since been occupied by the two great canals which run through the central portions of Ireland in such singular proximity to each other. In fact, the Grand Canal may be considered as forming almost the realisation of this project; for it runs very close to some of the above-mentioned rivers and joins the Shannon not far from Banagher.

2. The Barrow navigation, and a junction canal from thence to the Grand Canal at Munroe in the Bog of Allen. To this reference has been already made.

3. Improvements of the rivers Glyn and Bann, from Newry to Coleraine. The portion between Lough Neagh and Newry has been finished.

4. The Nore and Brusna navigation, from the junction of the former with the Barrow to the Grand Canal near the Shannon. Several docks and other works have been made in connection with the Nore, but this line seems to have been soon abandoned.

5. Improvement of the Liffey and Greece from Dublin to Kilcullen and Carlow. The Branch of the Grand Canal known as the Kildare Canal, runs very nearly in the district which this navigation was to open.

6. The Blackwater, from Youghal to Newmarket. It has been rendered navigable from Youghal to Lismore, and a few years ago, a small steamer was plying on this portion of the river, chiefly for passenger traffic; but as yet its capabilities, as a channel for the conveyance of goods, seem not to have been at all brought into operation.

7. The Foyle, Mourne, and Strule, from Derry to Omagh. This has been completed only to Strabane.

8. The river Erne, above Lough Erne, [unattempted].

9. The Maigue, from Limerick to Cork. Some improvements have been effected in this river by the Shannon commissioners, but the proposed line between Limerick and Cork has been long since abandoned.

10. The Boyne navigation, from the Grand Canal to the sea, at Drogheda. This has been effected, as already mentioned, from Navan.

11. From Sligo to Carrick-on-Shannon. This line seems to run nearly in the direction of the Boyle water, and is thus so far partly open.

12. From Galway to Killala, through the lake district of Western Connaught. This line, as already referred to, must be considered as unopened.

13. The Slaney, from Wexford to Baltinglass, [unattempted.]

14. The Suir navigation, from Thurles to Waterford. This has been improved only between the latter town and Clonmel, so as to admit of ordinary canal boats.

15. From Galway to Portumna on the Shannon, [unattempted.]

16. The river Inny, from Lough Sheelin to the Shannon, [unattempted.]

17. The river Suck, from Castlereagh to the Shannon. The Shannon commissioners have turned some attention to this river, but it does not seem to have been as yet rendered completely navigable.

18. The Lee, from Cork to Macroom. A few locks were constructed, but the works were soon suspended, and nothing has been effected since.

19. The river Bandon, from Kinsale to Dunmanway. Ships, such as are used in the coasting and channel trade, can proceed up the tidal estuary of this river as far as Shippool, a few miles below the town of Bandon; and a ship canal was proposed, some years ago, to connect the estuary with the town, for which surveys and estimates were made. This useful project has, however, been abandoned, and is not likely to be resumed, in consequence of the Cork and Bandon railway.

20. The Laune, from Rosscastle to Castlemaine harbour, [never attempted.]

The provisions of the Act of 1715 not having been found sufficiently encouraging, another was passed in 1729, better adapted in some respects to stimulate the carrying out of the several proposed improvements. New commissioners were appointed, and, by the 25th of George the Second, they were incorporated with full powers of improving and extending inland navigation. Certain duties were from time to time imposed, and specific grants accorded, in furtherance of these objects. For many years the commissioners had expended the sums placed at their disposal on the Newry navigation. In 1749 their expenditure amounted to 58,400*l*. After this they commenced other works on the Boyne and Shannon, the expenditure on which, in 1758, amounted to 140,000*l*.

In the 27th of George the Second an act was passed to open a navigation from Belfast to Lough Neagh. This is what is now known as the Lagan navigation; it was commenced in 1755, and received improvements in 1810. A new act was passed n 1843 for deepening it from the first lock towards Belfast, so as to admit vessels of from 50 to 70 tons burthen, and drawing 5 feet of water. This navigation is remarkable from an official testimony to its success, quoted by Mr. MacMahon, from which it appears that it has been but little affected by the Ulster railway, and for all heavy goods it is expected to command a preference. In th s opinion Mr. MacMahon concurs, stating that he has long entertained the conviction that canals and railways in the same locality are not necessarily competing highways.

At the period referred to of the reign of George II., when the entire revenue of Ireland scarcely exceeded half a million, the legislature voted 65,000*l*. for inland navigation. This was done chiefly on the representations of the Tillage Committee, by whom the subject was strongly recommended on account of the great benefits resulting to agriculture.

In 1767 the system of management underwent a change, devised in order to stimulate private enterprise. For, while granting 6000*l*. for improving the Lower Shannon, the condition was annexed that 10,000*l*. should be raised by private individuals, and in conformity with this arrangement the Limerick Navigation Company was duly incorporated. Some years after this the corporation for the general management of inland navigation was dissolved, and several lines of water communication that had been undertaken, were vested in bodies of local commissioners, such, for instance, occurred to the Newry Navigation, the Boyne, the Barrow, the Upper and Middle Shannon, and the Tyrone Coal Canal.

In 1789 the Irish House of Commons resolved to advance one-third of the expense of any new undertaking of this kind, and authority was given to issue debentures at 4 per cent. for 200,000*l.*, the sum raised in one year not to exceed 25,000*l.*

This liberal provision soon caused the following lines of navigation to be carried on, for which public money was allocated to the extent of 189,200*l.*

1. The Shannon, between Killaloe and Limerick.
2. The Grand Canal to the Shannon.
3. The completion of the Barrow Navigation.
4. The Royal Canal, from Dublin to the Upper Shannon at Termonbarry.
5. The Boyne Navigation, above Drogheda.
6. The Newry Navigation.
7. The Erne Canal.
8. The Kildare Canal, to Naas and Kilcullen.

The sum of 33,399*l.* was further appropriated by the 31st of George III. for the following improvements; the Athy branch of the Grand Canal, the Grand Canal docks, the Foyle Navigation to Strabane, and the Collieries Canal. From a report of the commissioners of accounts in 1790, the corporation for promoting inland navigation in Ireland had disbursed of

| | | | |
|---|---|---|---|
| Public Grants ............ | £227,669 | 2 | 1½ |
| Income for Duties ...... | 359,868 | 9 | 6½ |
| | £587,537 | 11 | 8 |

At the Union in 1800, a sum of 500,000*l.* was granted for improving the Port of Dublin, for rendering the Shannon navigable from Lough Allen to the sea, and for the general purposes of inland navigation. Under this arrangement 423,798*l.* were granted partly to the Royal Canal Company, the Barrow Navigation, the Grand Canal Company, for improving the Shannon between Lough Ree and Lough Derry, the Limerick and Killaloe Navigation, the Newry Navigation, the Tyrone Canal, and the improvement of Dublin Harbour. Subsequently by the 57th George III. cap. 34, 300,000*l.* was advanced for different works, no part of this grant going to the Shannon. After so many years of comparative neglect, the capabilities of this noble river were at length destined to be fully recognised, and to be in some measure availed of by the exercise of engineering skill and judicious legislative arrangements. The Shannon Commissioners were duly incorporated, and plans for the improvement of the river were submitted to Parliament every year from 1836 to 1839, inclusive. The entire estimates amounted to 510,750*l.* 15*s.* 9*d.* and the money awarded for compensation to mill owners, land owners, proprietors of fishery rights, &c., reached the sum of 74,054*l.* 2*s.* 0½*d.* The Shannon was thus not only brought to the navigable condition already described, but communication between its opposite banks was further facilitated by the construction of several noble bridges; and it is to be hoped that the prosecution of improvements of every kind of which the navigation of the river has been the object, have not as yet been altogether abandoned.

From this short sketch of the history of inland navigation in Ireland, the liberality with which the subject was entertained by the Irish Parliament is as remarkable as the occasionally injudicious application of the funds so amply provided. Sums comparatively small were appropriated for the improvement of the great natural lines of navigation, while far more encouragement was given to lines entirely artificial, more especially to the two great competing canals which connect Dublin with the Shannon. Thus the general interests of the country are frequently sacrificed to individuals or corporations who may exert an active and interested personal influence on those to whom the conduct of public affairs happens to be entrusted.

We have seen the great natural advantages which the physical structure of Ireland presents for inland navigation, and we have also been able to form some notions as to the way in which these advantages have been applied. Engineering works of great magnitude and solidity have been already executed, yet something still remains to be done in this department; but our observations in the present note will refer chiefly to the improvement in the locomotive arrangements of inland navigation, after a few remarks regarding the improvement of the principal water-ways.

Of these the first which demands notice is the Shannon, both as an independent line from Lough Allen to the sea, and as an important part of the great diametral line extending from Limerick to Coleraine. The condition of this noble river, as already pointed out, is such, that now no very important improvement seems possible, except that of rendering the portion between Limerick and Killaloe navigable, in the same sense as that between Killaloe and Athlone. When the engineering difficulties already surmounted on this river are duly remembered, and when we recollect that several miles of the navigation between Limerick and Killaloe is through the stream, the practicability of such an undertaking will not appear so problematical as many seem to consider it. The construction of a sufficient number of locks of the same magnitude as that at Meelick, or 170 feet long by 40 feet broad within the chamber, seems to form one of the most considerable items of expense. The chief objection to locks with a high lift is the great loss of water during the passage of vessels, but this objection would be scarcely applicable to a series of locks supplied by Lough Derg. If, with Sir Robert Kane* and Mr. Mulvany, we assume the maximum discharge at Killaloe to be one million of cubic feet per minute, and the minimum in the driest summer weather at 100,000 cubic feet per minute, and remember that an admirably-constructed waste weir, 1100 feet in length, now spans the river at this point, it will not need any calculation to be convinced that the supply would be almost inexhaustible for the purposes of navigation. Under these circumstances, the declivity of the river could be surmounted by a smaller number of the large locks than it is at present of the small locks. On the Leeds and Liverpool canal, where the supply of water is comparatively limited, five locks rise together 88 feet, thus giving each lock a lift of 17 ft. 7 in. If we allow to the current an average slope, somewhat less than 1 in 8000, for the 15 miles between Limerick and Killaloe, the lift required to be surmounted by the locks will not exceed 88 feet. The recent construction of floating docks at Limerick, and other improvements in that port, makes its connection with the Upper Shannon more important than ever. The completion of such works as are here referred to would enable sea-going screw steamers to traverse the greater part of the Shannon from its mouth upwards, and would thus establish a direct navigation between the central districts of Ireland, and the principal ports at the opposite side of the channel. In France and in Canada such tendencies of economising transport have been already manifested: the cost of breaking bulk and transhipment of cargoes having led, in the former instance, to the establishment of a screw line direct between London and Paris; and in the other to a very successful attempt to pass vessels of large tonnage over the rapids of the St. Lawrence, thus opening a direct communication between some of the great central lakes of America and the port of Liverpool.

The connection of Lough Erne with the Shannon by Lough Oughter was made the subject of a detailed Report by Mr. Mulvany in 1839. Although he does not seem to have contemplated the adoption of steam vessels on the artificial parts of the line, their introduction throughout might be effected by the use of the screw propeller, and the construction of locks sufficiently long. The moderate original estimate of 170,000*l.* for the entire work, would thus be slightly increased, but if this line of navigation should ever be finished, it must evidently be something better than a canal for conveying ordinary barges.†

The connection of the Shannon with Lough Neagh being thus established, a water communication would be open between the south and centre of Ireland and its north-east coast at Belfast and Newry; while a further opening could be made through the Lower Bann towards Coleraine. From the description already given of this river, it is evident that it presents such a series of levels, regularly descending step-like to the sea, as would present facilities for the establishment of locks, and if suitably improved, it would form a permanent line, adapted to vessels of sea-going dimensions.

* 'Industrial Resources,' 2nd ed. p. 82.

† Since this paper was written we have learned that considerable progress has been made with this canal, which is to connect Lough Oughter with the Shannon, near the southern extremity of Lough Allen, at Drumshambo, passing through the town of Ballinamore. It also appears that Mr. Dargan has, or had, a steamer plying upon Lough Erne, between Enniskillen and Belturbet, thus giving to the former town the advantages of the Ulster Canal. We have not as yet been able to get any data as to the size of the locks, and cannot therefore say whether provision has been made for steam-vessels.

Some important improvements might be suggested in others of the possible lines of navigation, especially in the lines of the Connaught lakes, and in the southern Blackwater, but want of data induces me to defer any further remarks of this nature.

The locomotive question of inland navigation requires the solution of two fundamental problems. 1. What is the best shape and construction of vessels for carrying a large cargo with the least draught of water, and minimum expenditure of tractive or propelling force? 2. What is the kind of motive power best adapted to the requirements of inland navigation?

The greatest immersion with the least vertical depth is evidently secured when the immersed section is a rectangle, in other words, when the bottom and sides of the vessel are flat, and the latter perpendicular to the former. This, therefore, should be the normal section of vessels intended for shallow waters, from which only slight and indispensable deviations should be permitted. Such a shape, combined with lightness of materials and general structure, would entail only a very small draught of water. The principal difficulty consists in combining these conditions with such lines as would present least resistance to the motion of the vessel in a narrow channel, or which would give the smallest value of K, in the formula

$$R = K W A H;$$

where R is the resistance, A area of maximum immersed section, H height due to the velocity of motion, W weight of a cubic foot of water, and K a constant depending on the form of the vessel. The least value of K seems to be that for vessels shaped on what is called the wave principle, for which Mr. Scott Russell states, he has found K = ·08, while the recognised values for ordinary shapes are ·16 or ·18. For canals and the shallow or narrow rivers of Ireland all these conditions should be very rigorously adhered to, and a class of boats totally different from the clumsy barges now chiefly used should be substituted. On this head, Sir John Macneill has addressed the following excellent remarks to the directors of the Grand Canal Company, which would be equally instructive to all who have any control over inland navigation in this country:

"The barges and boats on your canal are much too large, heavy, and unwieldy; they are a heavy load in themselves, and require considerable power to move them, even at a slow rate, when empty; they are also formed as if they were to be employed as sailing barges, similar to those on the Thames and other rivers; this is a great mistake, and quite unsuited to canal navigation. If the boats were built 60 feet long, 6 ft. 6 in. wide, with upright sides and upright sterns and bows, which would admit two of them to enter a lock at the same time, a great amount of saving would be effected on your canal in the power required to haul such boats, as compared with those now in use, for I have no doubt that six of these boats, carrying 35 tons each, would be as easily hauled as two of the present boats, 50 tons each, or in the ratio of 210 to 100."*

Although any future improvements in inland navigation in Ireland must necessarily be made with nearly exclusive reference to goods traffic, an instructive illustration of the manner in which the difficulties presented by shallow rivers may be overcome is afforded by what was done several years ago in France, on the Loire, by the skill and perseverance of a British engineer.

That river being deprived of its usual supplies of water during the heats of midsummer, steam-boats with the ordinary draught of water were found totally unsuitable. A new boat was constructed, 100 feet long, 10 ft. 6 in. broad, 3 ft. 6 in. deep, and 5 ft. 6 in. in height at the part containing the machinery. The material was sheet iron, $\frac{1}{11}$-inch in thickness. She was covered with strong canvas, so as to form a series of cabins, like in a canal passage boat, with small platforms fore and aft. A gangway ran all round, communicating between these platforms. The engine was 24-horse power, with a cylinder 16 inches diameter, and 2 feet stroke. Wrought-iron was employed as much as possible, and every part of the machinery made as light as could be consistent with the required strength. Engine, boiler, shafts, and wheels weighed only 6 tons. The boat and engine complete, was 14 tons. With a ton of coals in addition, she drew only 6 inches of water, possessing, as may be supposed, an almost rectangular cross section. She ran for some time between Tours and Orleans, and when the boats that run from Nantes to Angers were stopped from want of water, she was placed on that portion of the river, and is said to have soon realised the cost of construction. Four or five more steamers of the same kind were subsequently built, of greater dimensions, but not drawing more than 10 inches of water. These would, of course, be unsuited for rough weather, but seem to have admirably fulfilled the object for which they were intended.

The passengers being chiefly under the light canvas deck, the centre of gravity was always kept low during the voyage. It is also probable that when stopping at any of the stations on the river, the ingress and egress of passengers took place by the platforms at the end, and not at the paddle-boxes, according to the absurd and dangerous system generally in use, thereby avoiding the risk of giving so light a vessel a heel over the side, which, in such a case, would be attended with serious results.

Of the several modes of communicating motion to vessels on rivers, lakes or canals, the three most important are direct propulsion by steam, steam towing, and haulage by horses on the banks. The last of these labours under great disadvantages. The line of action is oblique to the direction of motion, whereby force is lost in different ways. If inland navigation is to be brought to any degree of perfection, this method must be entirely superseded. Whether it should be superseded or not, there are certain general principles relative to the motions of vessels in shallow and confined channels, a knowledge of which would very greatly assist in devising such arrangements as to economise the tractive or propulsive power applied to move the vessels. The mathematical and experimental researches of Professor Challis, Mr. Scott Russell, and Sir John Macneill, have added considerably to our information on these interesting questions. The following is a summary of their principal results:

The law of resistance in narrow and shallow channels is entirely different from that in open water. This is caused chiefly by the formation of a wave of considerable length, due to the impelling action of the vessel on the confined fluid, the velocity of which is a function of the depth of the channel. It moves most rapidly in deep channels, and slowest in shallow channels. This wave generally precedes the vessel, sensibly increasing the depth of water, a corresponding posterior depression follows it, which similarly lessens the depth of water. In shallow water, when a boat is behind the wave, an increased abnormal resistance is presented to her forward motion from the mass of water before her head. If by strong impulse she were placed on the wave, she would not only be in deep water, but would meet with diminished resistance. A boat moving in shallow water will sometimes take ground at places where she would float if at rest, and also pass over shallows at a rapid velocity, where she would run aground if her motion ceased or diminished. In the first case, if the vessel moves slower than the wave she will occupy the posterior depression, while in the second, if her velocity is equal to that of the wave, she is supported on it, and floats in a depth of water equal to the normal depth of channel, plus height of wave. Passenger boats on some of the canals of Holland are thus made to float over the shallower parts by giving them a higher velocity of motion. By lowering the velocity, the height and depression of the wave would be also diminished. When two boats are passing each other the effect is most sensible, as the resulting depression is equal to the sum of the depressions that would exist separately. I have frequently observed steamers to lessen their speed at low water in tidal estuaries, in order to prevent either or both taking the ground in the depression produced by their motions.

The practical conclusions are, that in narrow and shallow channels the increase of impelling power has a limit, and there is a certain velocity at which a boat may be impelled with a minimum expenditure of force. This velocity must, however, be attained very rapidly, in order to enable the boat to pass the wave, and a sudden impulse from a low to a high velocity is the best mode of effecting the change. In wide and deep channels the requisite impelling power increases with the velocity, but not in a uniform relation. In such cases, when it is hopeless to attain the same speed as the wave, the least velocity consistent with the requirements of traffic will produce least expenditure of power.

In applying steam power to inland navigation it becomes important to determine the best description of boats for navigating both rivers and canals, as well as the best for either separately. In France a great many boats have been constructed for such objects, moved by paddle-wheels at the stern, or by a single one in the centre, or more recently by screws. Among these is one constructed in 1852, on a principle similar to that pointed out by Mr. Bourne in his 'Essay on the Steam Navigation of Shallow Rivers.' She is capable of being divided into two separate parts, forming two distinct vessels, the forward division containing the

* 'Report on Screw Steamboats Employed on the Grand Canal,' p. 8.

goods and the after portion carrying the machinery as well as goods. The principal advantage gained by this mode of construction is the facility with which the vessel is enabled to pass through locks in separate divisions, for which she would be too long when entire. The project suggested by Mr. Bourne was anterior to this; he proposes a kind of floating train, analogous to the railway train on land. It is intended chiefly for the shallow and winding rivers of India, but as some of its details may be suggestive of improvements in vessels for combined canal and river navigation, we cannot forbear giving it some notice. He proposes to carry the passengers and cargo, not in the steamer herself, but in a succession of shallow barges, so articulated to the steamer and to one another by circular joints, with a single bow to separate the water for the entire train, instead of an independent bow and stern for each of the constituent barges. The steamer or floating locomotive proposed for the Indian rivers would be 220 feet long by 36 feet broad, with an immersion of 15 or 16 inches. The stern barge 160 feet, with less than 12 inches draught. Average draught of barges should be 12 inches, with 50 tons of cargo in each. In favourable cases he expects a speed of from 12 to 15 miles per hour, with a train of five barges. The locomotive, like that on land, carries neither goods nor passengers, she only differs in acting as her own tender. The barges should be so jointed together that only a narrow space would exist between them, at which the plates of the barges mutually overlapping, any intermediate water would be carried as in a tank, and could offer no resistance. Although in this way the resistance of displacement produced by such a train would be comparatively small, the resistances arising from friction and the flexures of the different parts of the train, would be very considerable. The frequent turnings which are requisite in river navigation would be accompanied by differences in the amount of effective resisting section presented by the train, and the midship section would almost always be far less than that representing the resisting surface. It seems probable, therefore, that there is a limit beyond which it would be injudicious to extend the length of such a train, although it must be acknowledged that it possesses great superiority over the system of towing a group of separate barges.

In the first part of these notes I have mentioned that steam power had been applied to the towing of barges on the Shannon, with very useful results. In the experiments made by Sir John Macneill it was found that a much more useful effect was produced in the application of small screw steamers on the Grand Canal by hauling loaded boats, than by carrying goods. But these steamers were essentially tug-boats, and the results obtainable from them cannot fairly determine the relative merits of the two systems of transport. On some of the rivers of France, such for instance as the Rhone, the carrying system has entirely superseded hauling, and cargo steamers of colossal dimensions have been recently introduced for the transport of goods. Some of these are 460 feet long by 22 feet broad, and have an average draught of 4 ft. 3 in. They are worked by engines of about 400 horse power, and move at the rate of from 5 to 6 miles an hour. On the Rhine and Danube the use of cargo steamers seems also to be gradually extending, with a corresponding diminution in the amount of towing.

If the system of jointed vessels already described should not be found to answer, the best application of steam-vessels to the existing canals, would be undoubtedly for towing purposes. I was surprised to learn from an intelligent gentleman connected with one of our principal canals, that the use of tug steamers was not of late regularly continued on the canal. One of the reasons alleged was, that a train of two boats occasioned a great and sudden loss of water at locks. This could be in part obviated by the suggestions of Sir John Macneill; and it should be remembered that the absolute loss would in any case be the same, whether the boats were in a group or separate. Another objection arose from the liability of the sparks from the funnels of the steamers lodging in turf ricks and the roofs of thatched buildings near the canal bank, thereby causing destruction of property. This is no doubt partly due to the lightness of the ashes of the peat, the fuel generally consumed in the canal steamers, but without any change in the description of fuel (which on economical grounds it would be desirable to retain), this evil could assuredly be averted. Spark arrestors are well known, and frequently employed on the chimneys of railway locomotives.

If difficulties of this kind should interfere with the development of inland navigation in Ireland, all the advantages she possesses would be in vain; and it would be long before we could say in the words of M. Gaudry, a French engineer, whose 'Essay on River Navigation in France' I have found both interesting and instructive:*—"Alongside of the best made and most prudently worked railways, each year witnesses, together with increased traffic on our improved water-ways, an increase in the number and power of the steam vessels."

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## THE MINTS OF THE UNITED STATES.

### By Professor Wilson.†

The transmissions of gold from the new state of California have caused a corresponding increase in the gold currency of the States, and have invested the Mint operations with more general interest than under the previous ordinary circumstances they possessed. The same condition of things exists in this country; and as it is intended to establish a mint in the gold producing colony of Australia, I thought it desirable to obtain as much information as I could in reference to the organisation and working details of those in the United States.

The head establishment is at Philadelphia, and is called "The Mint"; there are also three "Branch Mints;"—at New Orleans, in Louisiana; at Charlotte, in North Carolina; and at Dahlonega, in Georgia, respectively. The Branch Mint in California, and the Assay Office in New York, are not yet completely organised.

At the Mint in Philadelphia, gold, silver, and copper, are coined; at New Orleans, gold and silver are coined; while the branches at Charlotte and Dahlonega coin gold only. At "The Mint," the executive staff consists of a director, treasurer, chief coiner, melter and refiner, engraver, assayer, and assistant-assayer. At the New Orleans Branch Mint the staff consists of a superintendent, treasurer, melter and refiner, and coiner; and at each of the other two branch mints there are but three officers,—superintendent and treasurer (combined), assayer, and coiner. The several duties of these officers, the remuneration they shall receive for their services, and the amount of security they shall give for the due performance of them, are duly prescribed by an Act of Congress supplementary to the Act entitled "An Act establishing a Mint and regulating the Coins in the United States;" this latter act giving all the details referring directly to the coinage of the country.

At the United States Mint at Philadelphia, the salaries are fixed as follows:—Director, \$3500; treasurer, \$2000; chief coiner, \$2000; melter and refiner, \$2000; assayer, \$2000. At the New Orleans Branch Mint the salaries are, to the superintendent, \$2500, and \$2000 each to the other officers; and at the other branch mints the superintendents receive \$2000, and the other officers \$1500 respectively. In each of the establishments the appointment of assistants, subordinate officers and servants, is left entirely in the hands of the chief of the different departments.

In visiting the Mint at Philadelphia I had the advantage of being taken through the several departments by the chief coiner, Mr. Franklin Peale, and the melter and refiner, Professor J. C. Booth, who kindly furnished me with the following details of their operations. As the gold is brought to the Mint in various quantities and in a crude state, it passes necessarily through the department of the refiner before it reaches that of the chief coiner; I therefore give the actual details of the refining operations upon sundry deposits of gold, amounting in the aggregate to \$2,000,000.

The deposits are immediately weighed and a certificate of their gross weight issued. The fires having been lighted in the five furnaces of the deposit melting-room at four or five o'clock, A.M., all the deposits, amounting perhaps to seventy or eighty, are melted before noon; assay slips are then taken off and the assays finished‡ the next morning, after which their values are calculated by the weight after melting, care being taken to include all the grains that can be procured from the flux, pots, &c., by grinding them up under a pair of small chasers, sifting, and washing. There is a clerk and his assistant and one hand wholly engaged in performing all the weighings for the treasurer, such as weighing deposits before and after melting, ingots for coinage, fine bars, and the clippings after cutting out the planchets. There are five men in the deposit melting-room, two of whom

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* Armengaud's Publication Industrielle, Année ...

† From the Special Report on the New York Industrial Exhibition.

‡ The mode of assaying is according to the "wet process" of Gay Lussac. This is too well known to need description here.

attend to two furnaces each at the same time, one to one furnace and washing grains, and the remaining two are labouring assistants. The whole deposit of $2,000,000 is melted in three or four days in the deposit-room and assayed by from the third to the seventh day.

As soon as the first deposits are assayed, say on the third day (if expedition is necessary), or always on the fourth, they are granulated in the proportion of one part of gold to two parts of silver. The pots contains 50 lb. of gold and 100 lb. of silver, equal to 1800 oz., and each melt requires about an hour. With four furnaces (attended by four melters and two aids), there are ordinarily made thirty-two melts per day, but when hurried forty-eight melts can be made, making from one-third of a million to one-half of amillion dollars per day. Two days' work, or about $650,000 worth of gold, equal in weight to one ton (avoirdupois weight), are granulated for a single setting with acid. The granulated metal is charged into large pots, together with pure nitric acid of 39° Beaumé, between the hours of seven and nine A.M. on the sixth day, and steamed for five hours. The pots made in Germany, are 2 feet in diameter by 2 feet in depth, set in plain wooden vats, lined with $\frac{1}{16}$-inch sheet-lead; a single coil of copper pipe passing around the bottom of the vat blows the steam directly into the water in which the pots are set to about half their depth.

The vats are arranged in a small house in the middle of the room with a large flue connecting with the chimney-stack, so that when in action the odour of nitrous fumes is scarcely perceptible in the building. The $2,000,000 require about sixty such pots; they are stirred about once each hour, say altogether five times, with simple wooden paddles; the next day (seventh), the acid solution of nitrate of silver is drawn off by a gold-syphon into wooden buckets, and transferred to the large vat, in which it is precipitated by salt (chloride of sodium), and fresh acid added to the metals, now containing very little silver. Steaming for five hours on the seventh day completes the refining of $650,000. Early on the eighth one pot is drawn off, washed with a little warm water, and the gold-powder transferred to a filter. Fresh granulations are put into this empty pot, and the acid of the adjoining pot baled over upon them, and thus through the series, the whole being re-charged in from two to two and a-half hours. After steaming for five hours, the acid which contained but little silver from the preceding day becomes a nearly saturated solution of nitrate of silver. By this arrangement 4½ lb. of nitric acid are consumed altogether for each pound of gold refined, and the latter is brought up to 990 at 993 m. fine,—rarely below 990. Thus every two days, 13,000 lb. of nitric acid are used. In the course of the last year 1,000,000 lb. of pure nitric acid, at seven cents per pound, equal to $70,000, were consumed.

The gold is washed with hot water on the filter during the eighth day, and until it is sweet (say by 7 P.M.) The filter consists of two layers of tolerably stout coarse muslin, with thick paper between, in a tub with a false bottom, 2½ feet in diameter and 2½ feet deep, and mounted on wheels. One of the men remains, after washing hours, until 7 P.M., when the watchman of the parting-room continues washing the gold and silver until sweet, *i.e.*, until the wash-water ceases to colour blue litmus paper. Early on the ninth day the wet gold is pressed with a powerful hydraulic press, and the cakes then thoroughly dried on an iron pan, at a low red heat. This process saves wastage in the melting-pot, since there is no water remaining in the pressed metal to carry off gold in its steam. The same day (ninth) the gold is usually melted with a less proportion of copper than is requisite to make standard metal, and cast into bars, which are assayed by noon on the tenth. They are then melted with the proper quantity of copper, partly on the same day, partly early on the eleventh, and assayed and delivered to the coiner the same day. On the fourteenth they are ready for delivery to the treasurer as coins.

The silver solution drawn off from the pots is precipitated in a large wooden vat of 10 feet diameter by 5 feet deep, and the chloride of silver immediately run out into large filters [6 × 3 × 14] where it is washed sweet. The filter is covered with coarse muslin, and the first turbid water thrown back; the filter, which is on wheels, is then run over to the reducing vats, and the chloride shovelled into them. There are four such vats [7 × 4 × 2] made of wood and lined with lead, 1 inch thick in the bottom. A large excess of granulated zinc is thrown on the moist chloride in the vats, without the addition of acid; the reduction is very violent, and when it slackens, oil of vitriol is added to remove the excess of zinc. The whole reduction occupies a few hours, and after a night's repose the solution of mixed sulphate and chloride of zinc is run off into the sewer.

About 2 tons of zinc per $1,000,000 of gold are employed; the silver, however, in this amount, say 10 percent. by weight, should only take, by equivalents, about 2400 lb., so that nearly 2 equivalents of zinc for 1 equivalent of silver are used. This is found to be advantageous, as both time and space are greatly economised by this excess.

The day after the reduction the reduced silver is washed, and the second day it is pressed and dried by heat, the same hydraulic press as for gold being used, but with different drying-pans. The same silver is used again for making fresh granulations, but as it accumulates from the Californian gold, 10,000 or 20,000 ounces are now and then made into coin, great care being taken in this case to avoid getting gold in it when drawing off the silver solution, and in the press.

Such are the actual working details in refining a specified amount ($2,000,000) of gold, the first-third of which is delivered as coin in fourteen days after its arrival, and the third-third in eighteen days.

But as there is a bullion-fund of $5,500,000 allowed by government depositors are paid from the third to the fifth day after an arrival, *i.e.*, as soon as the gold is melted, assayed, and its value calculated. When two heavy arrivals occur in close succession, the time of refining and coining can be shortened from 14 to 10 days.

The number of men engaged in the refining department is 14: 1 foreman, 8 for the parting process, 3 for reducing, and 2 for pressing and drying. In the gold melting-room there are 3 melters and 2 assistants. The total number of hands in the melting and refining departments is 34, including a melting and parting foreman, and 3 in the place for grinding, sifting, washing, and sweeping. This last place or sweep embraces all pots, ashes of fires, trimmings of furnaces, ashes of all wood-work, &c.

The late law for reducing the weight of silver coin necessitated an increase of force, and 15 more were in consequence employed for this purpose. While $50,000,000 in a year have been parted with the above force, they could with the same force and apparatus refine $80,000,000 if it were required.

After many experiments upon anthracite, Professor Booth stated that he had at length fully succeeded in employing it for melting both gold and silver in the same furnaces, slightly modified, in which he had been accustomed to melt with charcoal. This change had been accompanied by great economy in the cost of material and labour, and by greater comfort to the workmen, from being less exposed to heat. The cost of charcoal (of the best quality—hard pine-knot coal) is 16 cents per bushel, delivered at the Mint; and while the cost of this fuel for all their operations in 1852, when gold was chiefly refined and melted, was about $7000, the cost of anthracite will be from $600 to $1000. In using the anthracite he found that a simple draught of air, without a blast, was quite sufficient to sustain combustion.

Californian gold frequently contains the alloy "iridosmine," which is not always detected by the assay. In order to remove it as far as possible without actually dissolving gold, it is allowed to subside, first in the granulating crucibles, and then in the crucibles for toughening (melting fine gold and copper). If the assayers report its presence in the toughened bars, they are again melted, and the iridosmine allowed to subside. By these three, and often four successive meltings, the gold is separated from its troublesome companion as far as practicable. The gold thus refined, and reduced to the proper standard [*Section* 8: "And be it further enacted, that the standard for both gold and silver coins of the United States shall hereafter be such that of 1000 parts by weight 900 shall be of pure metal and 100 of alloy; and the alloy of silver coins shall be of copper, and the alloy of gold coins shall be of copper and silver, provided that the silver do not exceed one-half of the whole alloy,"] is delivered over to the chief coiner in the form of bars or ingots of a certain weight, to be divided and shaped into pieces required for the currency of the country.

The *Coining* department of the establishment is of a power and efficiency sufficient to perform all the mechanical processes incidental to the issue of nearly 70,000,000 of pieces during the past year; and I was assured by Mr. Franklin Peale, the chief coiner, that it could have executed much more if it had been steadily employed, or fully supplied with material during the whole of that period. It is not necessary to go through the whole course of operations in this department, but to notice only such as possess novelty or present special characteristics.

The necessary power for working the machinery is obtained from a large steam-engine of the form usually known as the steeple-engine; it is a double vertical high-pressure engine, with cranks at right angles, the power being carried off by a caoutchouc belt, 2 feet wide, from a drum of 8 feet in diameter; the estimated power is equal to 90 horses. At times, this is all required, at others much less is sufficient, and in uncertain proportions; to meet this irregularity, and to insure that steadiness of motion so necessary in such delicate operations, a governor and throttle-valve of a peculiar construction have been devised which have now been in use for some time, and have produced most satisfactory results, fully effecting the purpose for which they were designed. The rolling mills, four in number, are driven by belts, at the rate of six revolutions per minute; the distances between the rollers being adjusted by double wedges, moved by a train of wheels which are connected with a dial-plate and bands, divided and numbered into hours and minutes, so as to indicate the proper thickness of the strips of metal without the use of gauges. Gold strips are heated in an iron heater by steam, and waxed with a cloth dipped in melted wax, and the silver strips are coated with tallow by means of a brush. The draw bench is used for both metals, and trial pieces are cut from every strip and their weight tested, preparatory to the cutting of the whole.

The cutting processes are very simple and efficient, consisting of a shaft moved by pulleys, and a 2½-inch belt, with a fly-wheel of small diameter but sufficient in momentum to drive the punch through the slip of metal by means of an eccentric of ⅜-inch, at the rate of 250 pieces per minute, which skilled hands can readily accomplish and continue until the slip is exhausted. The annealing during the rolling of the ingots into slips is performed in copper cases, in muffles of fire-clay and brick, heated by anthracite coal, three muffles or hearths being kept at a bright red heat by one fire-grate or furnace, and the distribution and intensity regulated by dampers. These annealing furnaces are recent in their construction and very satisfactory in operation; they are heated by anthracite at the cost of about one-fourth the expense of the wood previously employed.

The whitening of planchets is performed as usual by inclosing the gold in luted boxes, and by exposing the silver in an open pan, to the heat of a simple furnace with wood fuel; the drying and sifting after the action of dilute sulphuric acid, is rapidly and effectually accomplished by a rolling screen—one portion of which consisting of a pair of closed concentric cylinders, between which high-pressure steam is admitted. The blanks, with a sufficient quantity of light wood sawdust (linden or bass wood is the best), being introduced into the interior cylinder, a revolving motion is given to it by the engine for a certain time; the door is then opened and the blanks and sawdust gradually find their way into the wire screen by which they are separated, the movement being continued until the separation is complete, when the blanks are discharged at the end of the machine. An arrangement exists by which a slight inclination is given to the machine so as to direct the motion of the blanks towards the discharging end.

The milling machines are, I was informed, peculiar to this mint, and are in a great measure original, the operation being performed by a continuous rotary motion, with great rapidity and perfect efficiency, varying in rate according to the denomination of the coin, between 200 and 800 pieces per minute, and at the same time separating any pieces that are notably imperfect.

It must be understood that the operation here termed "milling," is merely for the purpose of thickening and preparing the edge, so as to give a better and more protective border to the coin, the ornament or reed, commonly known I believe in this country as "milling," being given to the piece by the reeded collar of the die in which the piece is struck.

The coining presses, 10 in number, and milling machines are worked by a high-pressure horizontal steam-engine, made from the design and under the direction of the present chief coiner, in the workshops of the establishment in 1838.

The presses are three sizes, the largest applicable to the striking of silver dollars and double eagles:—the second to pieces of medium value:—and the smallest to the dime, half dime, and 3 cent. pieces. The first is usually run at the rate of 80 per minute, the last at 104 per minute,—the average rate of the whole is 82 per minute. This rate can be increased if required.

If all the presses were employed in coinage at the usual rate, they would strike in one day (9 working hours) 439,560 pieces; and if employed upon gold, silver, and copper, in the usual manner, and on the usual denomination of coin, they would amount in value to $966,193.

During the past year, on one occasion 8 of the presses were run 22 out of 24 consecutive hours, and coined in that time 814,000 pieces of different denominations of coin.

These presses have been made principally in the workshops of the Mint. They possess in common with the presses of Uhlhorn, in Germany, and Thouellier in Paris, the advantage of "the progression lever," "le genou" or "toggle joint," a mechanical power admirably adapted to this operation; but in almost every other particular they are original in arrangement, being the result of experience, beginning as far back as 1836.

In order to supply these presses various means have been devised; among them and not the least important, is the "shaking box," in which advantage is taken of a disposition observable in similar bodies, or bodies of similar form, to arrange themselves in similar positions. This is a box, whose bottom is constructed with parallel grooves adapted to the size of the blanks or planchets to be arranged. A quantity of them is thrown indiscriminately into the box, which is then quickly shaken in the direction of the grooves, the pieces immediately lay themselves side by side in parallel rows, from which they can easily be lifted in rouleaux as required to be passed to the feeding tubes of the mills or presses.

It is very evident to all visiting the establishment that such a large number of pieces could not be coined and manipulated by such a limited number of hands without the aid of some labour-facilitating arrangements, one of the most worthy of remark of which is the method of counting the pieces coined—if counting it can be called, for in principle it is a measuring machine. The arrangement of this counting frame, or tray, may be understood from the following sketch of its construction.

A board or tray of such dimensions as may be required, is divided by a given number of parallel metallic plates dissected into its plane and slightly elevated above it, the edges of which rise no higher than the thickness of the coin for which it is intended. The board is of such a length as will admit of a few more than the required number of pieces to be laid longitudinally in the rows and is divided across and at right angles with the rows, and hinged at a point opposite to a given number. One of those employed by this department counted 1000 pieces, that is to say, it had 25 parallel grooves or rows sufficiently long to receive 45 pieces. Now, having thrown on this board a large excess of pieces, it is agitated by shaking until all the grooves are filled, and then inclined forwards until all the surplus pieces have slid off, one layer only being retained by the metallic ledge; the hinged division is then suffered to fall, which at once throws off all but the 45 pieces in the length of each row. This operation, somewhat difficult and tedious to describe, is performed in a few seconds, and results in retaining on the board 1000 pieces, each piece exposed to inspection, and the whole accurately counted without the wearisome attention—so likely to result in error—required under usual circumstances.

The very large number of pieces coined during the last year has been counted almost exclusively by two female manipulators, assisted by a man who had the duty of weighing them in addition as a testing check. The same amount of labour by ordinary means could not have been performed with fewer than thirty or forty hands, to say nothing of inferior accuracy. This machine was originally arranged and patented by the late R. Dyler, coiner of the New Orleans Branch Mint, but materially improved in its application and construction by Mr. Franklin Peale.

The balances of the Mint of the United States have received the attention necessary to an instrument of such importance in mint operations. They have been arranged and made generally in the workshops of the establishment, and operate entirely to the satisfaction of the department. It is not necessary to enter into details of their construction, as a full and minute description is given in the Journal of the Franklin Institute for July 1847. I, perhaps, ought to mention that since that appeared, some slight improvements have been made by inclosing all but the stirrups and pans in glass, by these means excluding dust and protecting them from the influence of air currents.

In concluding this brief sketch of the practical working of the two most important departments of the United States Mint, I cannot omit a reference to the very excellent remarks of the chief coiner on the employment of females in some of the operations in his department. This, he informed me, had generally excited the surprise of, and been commented upon, by foreigners, who had visited the Mint. His experience, however, had led him to believe, that in places of trust, where no great physical exertion was called for, but where accuracy and strict integrity were of first importance, the moral perceptions of the female, generally stronger and of a higher standard than in the man, would qualify her as his substitute, and thus, while opening a new field of labour for the occupation of females, would strengthen their claims to it by the superior accuracy and economy of their work.

## LIGHTHOUSE ON THE NEW SOUTH SHOAL, NANTUCKET, U.S.

REPORT *to the Senate of the United States, communicating, in compliance with a resolution of the Senate, a Report, Plans, and Estimates, from* Major HARTMAN BACHE, *in reference to the Construction of a Lighthouse or Beacon on the New South Shoal off Nantucket.*

TO THE HON. C. M. CONRAD, SECRETARY OF WAR.

SIR—In obedience to a resolution of the Senate of the 22nd ult., I have the honour to submit the report, plan, and estimate, in reference to a beacon or lighthouse upon the New South Shoal off Nantucket. The law on this subject is dated March 3, 1849, and is in the following words: "For a screw-pile beacon or other practicable structure on the South Shoal off Nantucket, lately discovered by the survey of the coast, twenty-five thousand dollars, to be expended under the direction of the Bureau of Topographical Engineers."

This shoal—called Davis's shoal, after the officer of the navy who made the discovery and the survey—lies about twenty miles from land, in the broad ocean. I do not know on whose plan or estimate the appropriation was based; but being satisfied that it was utterly impracticable to erect any durable and useful structure of the kind indicated in the law, for the amount appropriated, at such a locality, the bureau has limited its efforts to an investigation of the subject, and to the preparation of plan and estimate. Major Bache was assigned to those duties, and the report now submitted is from him. With his report are numerous and well-executed drawings of his plan, and of its details, and also a model, all of which are now in this office. With the report are sent such of the drawings and charts as he has indicated as necessary to illustrate the views and reasoning of his report.

The direction of the law being "for a screw-pile beacon or other practicable structure." it left the engineer free to the exercise of his knowledge and ingenuity, within the only limits prescribed to him by this office—namely, a beacon or a light-house.

From the estimates submitted, in accordance with the plan which he recommends, it will appear that the estimate for the lighthouse is ................ $322,786 78
For the beacon ................ 234,664 73
And that, for the operations of the first season there will be required, in the first case................ 190,589 20
And in the second ................ 157,530 21

These facts will, I hope, satisfy Congress that the course of the bureau, in reference to this appropriation, has been judicious.

The report of Major Bache exhibits with much force the necessity of some such structure as he recommends upon that shoal, and the bureau is clearly of the opinion that it should be a lighthouse, in preference to a beacon.

Of the appropriation of 25,000 dollars herein referred to, there has been drawn from the treasury, for the purposes stated in this report, no more than 2750 dollars.

J. J. ABERT,
*Colonel Corps Topographical Engineers.*

*Bureau of Topographical Engineers,*
*Washington, April* 14, 1852.

TO COL. J. J. ABERT, CORPS TOPOGRAPHICAL ENGINEERS.

SIR—I have the honour to present the following report, accompanied by plans and estimates, on a beacon for New South Shoal, off Nantucket.

The group known as the Nantucket shoals extends off seaward, from the island of that name, six to twenty miles, between an E. line drawn from Great Point, and a SSE. line drawn from Tom Nevers' Head. It comprises Old Man's, Pochick Rip, Bass Rip, Point Rip, and Old South and New (Davis's) South Shoals, with about forty smaller shoals and shoal spots, single and in clusters, without names, laid down for the first time, within the last few years, by the Coast Survey. These shoals, composed of hard sand, with depths from six to eighteen feet at low water, form an aggregate of about twelve square miles, and are scattered over an area of at least 375 square miles, or in the proportion of 1 to 30 nearly; the soundings between them vary from 3 to 18 fathoms. The direction of the currents through the group is entirely round the compass every successive ebb and flood, one half being occupied by the four "quarters" of the two tides; the flood, the eastern quadrant, from NE. the first, to SE. the last quarter, veering round to the east by the south; the ebb, the western quadrant, from SW. the first, to NW. the last quarter, veering round to the east by the north. Their greatest velocity is $2\frac{1}{2}$ miles; their least rarely less than half a mile, even at the period known in most other localities as "slack-water," and sometimes at that stage of the tide it exceeds a mile. These velocities increase greatly over the shoals, and with their courses are subject, as elsewhere, to be modified by the direction and strength of the winds. The rise and fall of the tide is 3 ft. 2 in.; the extreme rise, 6 ft. 9 in. In common with all parts of the eastern coast, the entire group is enveloped for many days at a time by dense fogs.

The shoals lying seaward of the island, itself separated by a channel of 25 miles from the main land, which there projects beyond the general line, form the most salient point of the coast, north and east of Cape Florida. The course from Sandy Hook to the seaward face of the group is about E. $\frac{3}{4}$ N., and thence due north, or nearly at a right angle to the mouth of Kennebec river; a line drawn between the same points, NE. by N., and cutting across the land, leaving the outer shoal nearly 140 miles seaward. The coast south of Sandy Hook trending less to the westward, the courses from the capes of the Delaware and Chesapeake incline more to the north, and hence lines from those points to the Kennebec cut off, seaward, correspondingly less of the land.

The foregoing account of the character of the bottom, the limited depth of water over the shoals, their number and small size compared with the large area in part out of sight of land, throughout which they are scattered in deep water; the great velocity and ever-changing direction of the currents, in every instance running across the shoals; and the prevailing fogs, coupled with the prominent position of the group, will show at the same time the important relation which these shoals hold to the course of a large portion of the commerce of the country; the great danger to which it is exposed in passing them; the necessity for marking at all times their seaward face, and the extraordinary difficulties which lie in the way of accomplishing so desirable an object. The value of such an aid to navigation can hardly be exaggerated. The advantages flowing from it would certainly not be inferior to those resulting from the marking of any other point of the extended line of the Atlantic coast. What now constitutes a danger and a dread to navigators, and consequently a positive injury to commerce, would in that event become a means of safety, and benefit it. Forming the great point of departure and arrival for that part of the coast, vessels, particularly those engaged in foreign commerce, would no longer approach the shoals under reduced sail or steam, but stand boldly on, and, having made the light, continue confidently on their course for their ports of destination.

The commerce most interested in the proposed measure consists of—

1. The British American and European trades, from all ports south of Nantucket, as far at least as the Chesapeake, and of all other foreign trades from ports north and east of the island;

2. The whale trade, the ports of which are principally in Nantucket and Martha's Vineyard, or on the main in the vicinity of those islands; and,

3. The coastwise trade between ports on either side of Nantucket.

The magnitude and value of the commerce under the first head, and the number of persons connected with it, either as seamen or passengers, will be seen from statement No. 1, appended hereto, condensed from statements A, B, C, D, also appended. It is confined, as sufficient for the present purpose, to the principal ports of New York, Philadelphia, and Baltimore, within the first geographical limits, and Boston, Salem, Portland, Bath, and Eastport, within the second, and shows a grand aggregate of 6177 sea-going vessels of all classes, valued, with their cargoes, at $252,345,286, and paying in duties $26,988,054, and carrying, without taking into account outward-bound passengers, of whom no record is made, 285,558 persons, as passing the shoal in a single year. To what extent the trade of the remaining thirty-two ports within the first, and the twenty-one ports within the second division, as given above, would increase these amounts, can only be surmised in the absence of the records of the respective custom-houses. That these records would increase them considerably, there can be no doubt.

The extent to which the whale trade is interested in pointing out the positions of these shoals, can only be determined with anything like accuracy by tracing the course of each vessel engaged in it, to and from her port. In the absence of this information, it is only necessary to know that this trade is carried on from ports on either side and in the immediate vicinity of the group, to be convinced that it is largely interested in the measure. Thus, of the 606 vessels engaged in this trade, 475 arrive at and depart from their ports by the passage east of Long Island, barely 50 miles wide, and distant at the nearest point not more than 30 miles from the group; 69 belong to Martha's Vineyard and Nantucket, or on the main, back of those islands which, whether inward or outward-bound, are exposed to the shoals; and the remainder, or 62 vessels, are from ports north and east of Cape Cod, which, as the fishing grounds are principally south and in the Pacific, must pass them both going and returning. The relation which the position of the Nantucket shoals has to the usual course of the whale trade being thus shown, it is only necessary to examine the statements herewith numbered 2 and 3, to see the interest which that most valuable trade has in the consummation of the proposed project. The first gives the entire whaling fleet on the 9th of September last, as consisting of 606 vessels of all classes, with crews numbering 14,538 men and boys, and having a tonnage of 189,622 tons, valued at $7,584,850. The second, the arrivals of the trade for 1851, footing up as follows: vessels of the four classes, 239; crews, men, and boys, 5559; value of vessels $2,929,340, and value of *catch* $10,238,784, and total value of vessels and *catch* $13,178,124. That is to say, assuming the correctness of the premises as stated above, the inward-bound fleet of the whale trade, having a value of $13,178,124, and manned by crews numbering 5559, is exposed in a single year to the dangers of these shoals. But this exposure is not confined to the inward-bound trade alone; the outward-bound trade should also be considered. A statement of this trade is not within reach, nor is it absolutely necessary for the purpose of this report; for assuming, as is reasonable, that to keep up the whaling fleet on the fishing grounds, the departures hence must compensate for the arrivals home, a sufficiently near result may be come at by taking the totals under the different heads in the statement No. 2, omitting that under the head of the value of the cargo or *catch*. With this reduction, the footings of the outward-bound whaling fleet per annum will stand thus: number of vessels 239; number of the crews, 5559; and the value of vessels, $2,929,340. For want of reliable data, no note is made of the cost of outfit of the vessels—an item that would add very considerably to the value of this trade.

As the coastwise trade passes for the most part through the Sound, between the island of Nantucket and the main land, that trade is comparatively but slightly interested in the proposed project. Whatever exceptions there may be to its usual course are probably confined to vessels trading between ports north and east of the island and the distant domestic ports of the Gulf of Mexico and the Pacific; and to vessels which, wind-bound by the channel through the Sound, take the risk of the outside passage. It may, however, be confidently assumed that if the outer point of the Nantucket group were at all times distinctly marked, these exceptions would increase, as a consequence of affording greater facilities to this valuable and growing branch of commerce. Of the extraordinary number of the vessels engaged in this trade which pass Nantucket island, either by the Sound or seaward, some conceptions may be formed (in the absence of a true record, which can only be obtained by a laborious search through the "Commercial Lists" of the day) from the fact that during the year ending the 30th of June last, there were *seen* to pass the Cross Rip light-boat, stationed in Vineyard Sound, some 12 or 15 miles north-westerly from Great Point Nantucket, no less than 44,431 vessels of the four classes; a record, let it be remarked, that, in consequence of fogs and the absence of a rigid look-out must fall far short of the actual number that passed that station.

Confining the value &c., of the commerce to the authentic statements under the first two heads—that is, to those having reference to the foreign and whale trades—it appears that 6655 vessels of all classes, carrying in crews and passengers 296,676 persons, and valued with their cargoes at $268,452,750, and paying in duties $26,988,054 (being more than one-half the entire revenue of the country from this source), pass and are exposed to loss by these shoals in a single year. If to these results were added the number of vessels, with their value and the value of their cargoes, and number of persons, of the foreign trades from the 53 inferior ports already referred to, and from ports south of the Chesapeake as far as Cape Florida, and of that portion of the coastwise trade which takes the outside passage at Nantucket; and were also added the value of the precious metals and the number of outward-bound passengers of the foreign trade—the principal statistics of which have been given—it is not unreasonable to believe that a grand aggregate would be shown to prove that property of the value of a million of dollars, and lives to the number of one thousand, are put in jeopardy every day throughout the year by these dangerous shoals.

The foregoing statements and remarks give a general idea of the great importance to commerce of pointing out, at all times, the seaward verge of the Nantucket group of shoals. In other points of view, the subject presents itself in a manner, if possible, still more striking. Between the port of New York alone and Europe, there are, at this time, four lines of steamers. Some of these steamers cost, "all told," to put to sea, about $233 per ton; or, for one of the largest, say $675,000. By the present schedule of sailing, the four lines make altogether 136 trips annually, passing, of course, the Nantucket shoals as often, or at the rate of one steamer for little over every two and a half days throughout the entire year. The cargoes of these vessels hence for Europe—being made up, for the most part, of the bulky products of the country—are not (if the precious metals, of which they carried in the year 1851 $43,673,209, be left out of the account), comparatively, very valuable. On the other hand, those of the inward-bound steamers, consisting mainly, as they do, of the most costly manufactured goods, are generally of great value. This value seldom falls below a quarter of a million of dollars, and at times rises above a million of dollars; and, if the newspaper accounts may be relied upon, in one instance actually amounted to double that sum. As a general rule, it may be assumed that the cargoes of more than one-third of the arrivals are worth over half a million of dollars. From this account it will not be deemed extravagant to set down these vessels, with their cargoes, taking the inward and outward trips, at a value bordering closely on a million of dollars; the destruction of any one of which, if of the American lines, would cause a loss of a like sum to the wealth of the country at large. Again: of the 136 trips in 1851, 67 were homeward passages, at the close of each of which large sums were paid in the form of duties into the treasury. These duties —as often, probably, above as below one hundred thousand dollars—on two occasions, being those on the arrival of the *Franklin*, from Havre, in January and July, actually reached the enormous sums of $311,378 50 and $329,070 80, respectively. Thus it appears that, besides the very heavy loss the wreck of any of these steamers would cause the country, the receipts of the treasury would be seriously affected; in two instances, to an amount that, if the measure be at all practicable, would probably point out, for all time, the position of these dangerous shoals.

To the trade under the first head, the project in hand is of more importance, as involving larger interests than that under either of the other two, and to all of more value in regard to the homeward than to the outward-bound trade. The ratio of equality in the dangers which at present exist between the inward and outward bound trades, so far as these dangers arise from the Nantucket shoals, is owing, it will be remarked, not so much to the intrinsic difficulties of the navigation of the latter (unless, indeed, there are unknown currents in their vicinity, or erroneous estimates of the direction and velocity of those that are known), as to the absence of proper caution in that trade in making an offing. The striking of the steamship *United States*, on her last voyage to Europe, and the total loss, with her crew, during last winter, of the ship *Ivanhoe*, on these shoals, within little more than twenty-four hours' run from their port of departure, New York, would, no doubt, were the circumstances attending these disasters known, prove the correctness of this opinion; and of which the statistics of the losses generally of the outward-bound trade, could they be got at, would probably be a further confirmation. But of all the homeward-bound commerce, to that from European ports is the marking of these shoals a measure of the greatest importance. Fully to understand why this must be the case, it is only necessary to state that the usual course of this most valuable trade is to make Cape Race, the eastern point of Newfoundland, and then run down the coast inside the Gulf-stream, which, by the jutting out into the ocean of Nantucket and its shoals, here approaches nearest the land. The passing of the shoals is hence a proceeding of great peril, causing a corresponding anxiety to all who are engaged in this trade. Nor are the peril and anxiety confined to the navigators of sailing-vessels; they are largely shared, notwithstanding the more perfect means by "dead-reckoning," in the absence of the usual "observations," to determine the vessel's position, by those in charge of steamers, more than one of which, in the short period this class of vessels has been employed in transatlantic navigation, have been involved in the intricacies and dangers of these shoals.

The foregoing remarks upon the value of the commerce, and the dangers of the navigation described, sufficiently manifest, it is hoped, the great importance of the contemplated project. They might be readily extended and supported by further statistics, not only of the commerce proper, but of the losses of property and life. But this more properly belongs to the legislator than to the engineer, whose province it is rather to show in what way and at what cost, the work in hand, so essential to the safety of trade and of human life, may be accomplished.

New (Davis's) South Shoal is the most seaward shoal of the Nantucket group. It lies out of sight of land, south by east-half-east, broad off from the island of the same name, twenty miles distant. It is composed of fine white sand, quite hard and compact; the least depth of water on it at mean low water being 8 feet. The mound is stable, though no doubt subject to superficial variations, as all such alluvial formations are, particularly in situations exposed to the extremes of weather. The extent of the shoal within the two-fathom curve is one and a half mile, by a mean width of about one-eighth of a mile; and within the three-fathom curve two and one-twelfth miles, by seven-twelfths of a mile. The shoal falls off rapidly into deep water on all sides, particularly seaward, in which direction the soundings, in a distance of a mile and a half, increase to fifteen fathoms. As its general course is east and west, the currents, as already described, necessarily run most frequently more or less across it. It is exposed on the land side from north (Cape Cod) to west (Montauk Point), or throughout one-fourth of the circle, to a sweep of the sea varying from twenty miles to one hundred miles; and from the north, round by the east and south, to the west, or for the remaining three-fourths of the circle, from one hundred miles to the extreme reach of the broad Atlantic. The nearest harbours to the shoal by a steam line are Nantucket, 40 miles, Edgartown, 42 miles, and Holmes's Hole, 46½ miles.

There is no reason to suppose that New South Shoal is of recent origin. Like all the shoals forming the extensive group known as "the Nantucket shoals," it is the result of causes which have been in operation from a remote period. Whatever difference in age, if any, exists between it and the other shoals of the group, is wholly due to its greater distance from the land. That it has until late years been confounded with "Old South Shoal," is highly probable. Their size and depth of water, and comparatively near proximity, but, above all, the ever-varying direction of the currents in the vicinage of the shoals, and their positions out of sight of land, would seem to favour the correctness of this opinion. What previously was considered as one and the same shoal, has by the Coast Survey been found to consist of two distinct shoals; a result no less creditable or important from the labours of that great national work, than the discovery and marking of a new shoal.

It is doubtful whether, when its true character is reflected upon, and especially the exposure of the position, the depth of water and nature of the soil at the site, and its distance from land and a harbour, any project in the whole range of maritime construction has ever been entertained which presented so many difficulties in the way of its accomplishment, as the one under consideration. Such was my first impression, when, with only a general knowledge of the circumstances involved in the measure, the bureau thought proper to direct my attention to it; but my early impressions gradually became a settled conviction, under the influence of facts newly-developed, investigations anxiously made, and reflections consequently arising. While under such a persuasion, therefore, it would be affectation on my part, if I were to pretend that I feel no diffidence of my ability to solve so difficult a problem. If I may not recommend the true course to be pursued for consummating so great and important an undertaking, it will be truly regretted by me; but I shall have the satisfaction to know that I engaged in the task with a due sense of my obligations, and a single and earnest desire to do so, free from all bias for or against any particular system of construction.

Instances are not wanting of works founded at positions exposed to the extreme violence of the ocean, which have triumphantly defied its power; and among them may be especially mentioned the Eddystone, Bell Rock, and Skerryvore light-houses. But in all these instances the conditions under which the structures were raised, were widely different from those of the project which is the subject of this report. Those structures were founded upon rock, always or at times exposed above the level of the sea; they were less distant from land and a harbour, and open to the sweep of the ocean through a smaller arc. In these observations, far am I from desiring to undervalue the genius which designed, or the indomitable energy and perseverance which successfully raised, these renowned works. My desire is rather to express more emphatically my appreciation of the serious difficulties and hazards which are to be encountered in carrying out the project under consideration. The accompanying statement, made in the form of a table, will exhibit at a glance the "conditions" of each of the three positions or works just named, side by side, as compared with New South Shoal; extended, for future reference, to the cost and the time consumed in the erection of each work, those for the latter being, of course, only estimated.

No work of a solid character placed on a submerged sand at so exposed a point as New South Shoal, were it possible to found one, could long withstand the power of the ocean. That it would not be overthrown by the direct blow of the waves, the successful resistance of the works just named, at points where the inclination of the bottom and the depth of water are calculated to give greater force to the waves, prove beyond all reasonable doubt; but that its destruction would nevertheless be inevitable, from the rapid and ceaseless process of the wasting of the sands of the shoal, caused by the recoil of the sea from the mass, is no less certain. To provide a base of sufficient size and strength to sustain the necessary superstructure, that shall at the same time offer no very sensible obstruction to the free passage of the currents and the waves, is the great desideratum in founding works on submerged soils exposed to the batter of the ocean. This desideratum the last few years has supplied in the screw-pile of Mr. Alexander Mitchell, of Belfast, and in the pneumatic pile of the late Dr. Lawrence Holker Potts, of London. The next inquiry in order is, whether either of these modes is applicable to the site at New South Shoal. After much reflection, aided in no small degree by the experience acquired in the erection of the light-house on the Brandywine, I am of opinion that the first, being the method of screw-piles, cannot be employed to found a work at that point; and for these reasons:

1. That the screws could not be made to penetrate the shoal to the required depth, by any means applied from a *floating* body, moored in the tide and sea-way at the point in question.

2. That it is not possible to erect a temporary fixed structure during the working season at so exposed a point, at least in time to be available for driving the screw-piles; and,

3. That if it were possible to raise such a structure in time, it is doubted whether any power applied from it could insert the piles, to the necessary depth, into a sand so hard and compact.

The screw-pile has been successfully applied in forming foundations of light-houses on the Maplin Sands, mouth of the Thames; on the North Wharf Sands, mouth of the Wyre; on the shoal ground off Holywood, Belfast bay; and, in this country, on Brandywine shoal, mouth of Delaware bay. The attempt to erect a light-house on the north end of the Kish Bank, in St. George's channel, by means of these piles, failed, from no defect in the principle claimed for these useful appliances in forming submarine foundations, but principally, as it is understood, from the coming up of a heavy gale from the south-east before the piles were properly braced and the diagonal stays attached. The design to raise a beacon of screw-piles on the eastern end of the

Tongue Bank also proved abortive; but, as in the case of the structure on the Kish Bank, from no inherent defect in the piles themselves. This beacon was composed of five six-inch piles, and raised in position by the Trinity House. Shortly after it was put up, it was discovered that an accident had happened to it, and, on examination, it was ascertained that three of the piles were broken off short, and the other two bent. The stumps of the broken piles, and the lower parts of the bent piles, were found perfectly upright, and the sand around them undisturbed; showing the structure failed from no fault of the *hold* they had taken of the ground. Their condition indeed affords the best evidence of the capacity of the screw-pile on this point, as it appears the force that was sufficient to break off three and bend two wrought-iron piles of the size stated, was, at the same time, unequal to the task either of uprooting them or even changing their position in the bottom. As the force of the waves, acting on such small surfaces as these piles presented, was entirely inadequate to produce the effects described, the destruction of the beacon was sought for in other causes. The conclusion arrived at, at the time, and no doubt the correct one, was, that a vessel had passed over it; a conclusion in a measure confirmed by finding the copper of a vessel attached to the top of one of the bent piles. It may be remarked here, incidentally, that accidents from this cause form the only real objection, save the destructible character of the material, either to the screw-pile or the pneumatic-pile, and only then of works founded in navigable depths.

In every one of the instances cited of these constructions in England and Ireland, rafts or pontoons, or boats built expressly for the purpose, were used to receive the power employed to drive the screws. But the circumstances under which this operation was carried on were, in every case, widely different from those which would control it at New South Shoal. In no instance was the exposure as great, and in three much less, and in all the soil afforded greater facilities for penetration. An account of the several localities in question, so far, at least, as to include the characteristics which govern in such operations, compared with that already given of New South Shoal, will at once make this manifest.

The Maplin is on the West Swin channel, at the southeast point of the shoal ground known under that name, and about 4½ miles from the shore, where the Thames expands to a width of 20 miles. The site is bare at the lowest water of spring tides, and the " sand of the bank of an exceedingly soft nature." The soft character of the soil is very evident from the fact stated in the account of the erection of the light-house, that the nine piles, with screws as large as 4 feet in diameter, forming the base of the structure, were driven into the bottom from a raft, by 30 men, to a depth of 22 feet, in the short period of 9 days.—The Wyre light is also situated on a low-water bank connected with the land, from which it is but 1¾ mile distant. Though open towards the sea for a considerable arc, it is protected from its roll by large areas of shoal-ground, which lie off in that direction. One account states that " the bank was found to be sand, but of a much harder description than at the Maplin," and that the screws of 3 feet were " sunk 13 feet into the bank;" another, that the entire penetration was but 10 feet; the first 7½ feet being sand, the rest marl. It is scarcely necessary to remark that a soil may be " much harder" than one described as "exceedingly soft," and yet may not be very hard.—The light off Holywood is in 10 feet at low tide, within a quarter of a mile of a low-water point, and less than a mile of the shore off Belfast bay, where it is little over two miles in width; a position, certainly, of no great exposure. The soil is described as " hard sand and gravel for 7 or 8 feet, then soft tenacious clay." The screws employed were 3½ feet in diameter; but how far they were entered into the bottom the published accounts, as far as these have been met with, do not state. Materials uniform in size and homogeneous in character, form the most compact and impenetrable bodies. This is seen on a large scale in the greater stability of the sea slopes of breakwaters, formed of masses of stone of a uniform size, over those composed of stones of different sizes, and in the greater firmness of the road-bed of M'Adam, of which it is the leading principle, compared with the roads previously made. The same rule applies in a measure also to soils, and will afford the best criterion by which to judge of the facility these screws, or indeed any other form of body, may be thrust into them. Had that composing the site off Holywood been all of sand, or all of gravel of uniform or nearly uniform size, the penetration by the screw would no doubt have called for a much greater power than it is understood was used on that occasion, or, what is the same thing, the same power, if applied afloat, applied from a fixed basis. As it was, the separation of the larger bodies by the smaller ones afforded facilities, by the latter acting as so many minute rollers on the former, not only to enter the screws into the soil, but also to accelerate their descent to the depth required.—The Kish Bank, at the site of the light that was proposed to mark its northern end, is about 11 miles from the main land, with a depth of 13½ feet at low water, and a rise of tide of 13 feet. The bottom is represented as consisting of " sand of an exceedingly hard and dense description." The screws were intended to be planted 12 or 13 feet in the bottom, but it was found impracticable, with the means employed, to penetrate the bank to a greater depth than 9 feet.—The Tongue Bank, or Sand, is at the mouth of the Thames estuary, and hence more exposed than the Maplin, which, besides having the protection of a greater extent of shoal ground seaward, is some few miles further removed from the ocean. The position selected for the proposed beacon was on the eastern end of the bank, in 17 feet water (another account says 9 feet) with a rise of tide of 15 feet. The screws, which were but 2 feet in diameter, it is stated, were sunk into the soil, described as " ground exceedingly hard," to the depth of 17 ft. 9 in. It will be remarked that the exposure and depth of water in the last two instances are much greater than at the positions first named. How it was possible in these cases to apply an adequate power from a floating body (under the circumstances more difficult to maintain in a given position), to insert screws of the size used, to the depths stated, in soils such as those described, it is difficult to conceive. The only way to reconcile what otherwise is inexplicable, particularly to those having any experience in such operations, is to take the expressions applied to the soil, as in the case of that of the site of the Wyre light, in a *comparative* and not a *positive* sense. This probably is the true explanation, and accounts for whatever success attended the attempts to apply the screw-pile at the Kish Bank and the Tongue Sand; an explanation in a measure confirmed by the fact that the piles in the case of the former, though buried up for a depth of 9 feet, could not stand alone, or, in other words, that the soil, under the action of the sea, on even so small a surface as the shaft presented to it, was, from its soft nature, incapable of sustaining them.

It is evident from these statements, that in all the cases mentioned, the soil, if not *absolutely*, was *comparatively* soft, and that this characteristic alone admitted of the employment of floating bodies from which to apply the power in driving the screws. At the Brandywine the employment of the same means would have signally failed. The preliminary examinations of the shoal gave palpable evidence—which, if possible, was more than confirmed by the subsequent operations—that a more stable footing would be required; for so far from being able, with such means, either to give the piles their proper relative positions, or to sink them to a depth which at that point would have secured the stability of the superstructure, it is doubted, indeed, whether they could have been inserted far enough to be able to stand alone. If this be true in regard to the Brandywine, it will hardly be contended that the application of the same imperfect means would meet with better success at New South Shoal, where the circumstances (excepting the character of the bottom, which, judging from the specimens and *feel*, may be considered of the same description) of distance from the land, and a harbour exposure and depth of water, &c., increasing the sum of the difficulties attending such operations, are greatly exaggerated.

The experience at the Brandywine is alone relied upon in support of the opinion contained under the second head. The fixed structure or platform at that point stood 19 ft. 9 in. above the shoal, and was 55 feet square, with a projection at one corner, in all forming an area of 3587 feet, and consumed 74 days of the working season of that locality in its construction. At New South Shoal a structure of the same description, large enough for the intended purpose, would have a floor of about 80 feet square, and an area of about 6400 feet, and would be elevated 38 feet (as will be shown hereafter) above the bottom—that is, it would be about double the area and height, and three and a half times the cubical dimensions, estimated from the surface of the shoal in each case, of the one on the Brandywine. Whether the time required for the erection of two structures of the character of those in question, would, under like conditions of exposure, &c., be as the areas of the floors and the heights from the bottom, or as their cubical contents above that plane, is a question of which the present experience in such operations affords no satisfactory solution. It is enough, however, for the present purpose, in the absence of any definite rule on the subject, to show that—assuming even the most favourable view of the case, and taking no account of the greater exposure and depth of water, and the increase of distance from 13 to 42 miles of a harbour of refuge in the case of New South Shoal, and conceding also that proper skill and due diligence were exhibited in the operations at the Brandywine—it would not be possible to raise the required structure at that point within the season of operations (limited in that latitude to five months, from May to September inclusive, or 153 days), and leave sufficient time either to perform the final operation of inserting the screw-piles, or to make up losses of time contingent upon all similar undertakings exposed to delays from vicissitudes of weather.

Neither is it probable, as stated under the third head, that recourse to a fixed structure, such as was employed at the Brandywine, were it possible to erect such a one on New South Shoal, would prove successful, except in giving the piles their true relative positions, and this for the reason of the great elevation above the point of resistance of the mechanical power, which would be so far spent in the mere torsion of shafts of so elastic a material as wrought-iron of the length required, as to prove unequal to the due penetration of a sand as hard and dense as that which is described to be at the point in question. The elevation at Brandywine shoal was 23 ft. 9 in., made up as follows: 6 feet for depth of water at lowest spring-tide; 7 ft. 6 in. for rise of highest tides observed (12 feet being the rise of storm-tides); 6 ft. 3 in. for height, including 2 ft. 3 in. for thickness of platform above highest tides observed; and lastly, 4 feet for height of the capstan-drumhead employed to drive the screws above the floor of the same. It was the original intention to insert the screws in the shoal for a depth of 15 feet; but it was only after the most strenuous exertions, with a force of thirty men working the mechanical power above mentioned applied to a spur and pinion wheel attached to the shafts of the piles as low down as the water would permit, that they were buried up in the sand for a little more than 10 feet.

At New South Shoal, the measurements that would go to make up the distance between the point of resistance and the point at which the power is applied, considered with the size of the shaft as the governing condition in the case, are greatly increased, as will be seen from the following statement. The depth at low water at the point proposed to occupy on the shoal is 14 feet, the extreme rise of the tide 6 ft. 9 in. A platform beyond the reach of the sea should not be less than 15 feet above the level of the highest water, as the waves, by striking against the many vertical obstructions presented by the wooden piles forming the temporary structure, might, at the limited depth named, be thrown upward against the floor of that platform in such masses as to endanger its safety. Thus, the height of the platform, including 2 ft. 3 in. for the thickness, would be 38 feet; add to this 4 feet for the height of the capstan-drumhead above the platform, and the whole height is increased to 42 feet, being also the least distance between the points of resistance and application of the power, and, as a consequence, the least length of shaft through which the power to drive the screws must be exerted—a length that would seem sufficient, in view of the experience at the Brandywine, to defeat every effort, notwithstanding the increased size of the shaft to 12 inches, to insert them to a depth to insure the safety of the superstructure.

The pneumatic pile of Dr. Potts is of more recent origin than the screw-pile, or, at least, has not been so long known to the public. It has not yet, it is believed, been successfully applied in founding works, such as lighthouses, beacons, harbours, &c., exposed to the sweep of the ocean. That it is practically applicable for the purpose there is every reason to believe. The favourable opinion of those well known in engineering and construction in Great Britain, communicated in the report on the ice-harbours of the Delaware, dated the 28th December last, may be received as conclusive, particularly as it is supported by cases of application already made in other, and in some respects kindred works, on this point. To this testimony and to these cases the bureau is again referred for all the information in possession of this office upon the subject. Of the latter, it is deemed sufficient for the present occasion to recount merely the following instances in which these piles have been used, to show that their size, both length and diameter considered, would seem only limited in their application to the power under the circumstances to handle them. Besides being employed, among other instances, in the founding of the piers of a viaduct in Anglesey over an arm of the sea, the bed of which is of running sand and gravel of great depth; in an experiment on Grain Spit to test the powers of the pile to sustain great weights; in the sinking of a pile of large dimensions in a quicksand in Cornwall; in the construction of a bridge over the Thames at Datchet; and in the foundation of part of a large viaduct on the Holyhead line of railway, a pile of this description, 3 feet in diameter, has been sunk in the Goodwin Sands to the depth of 77 feet, to the chalk formation; and others of the enormous size of 10 feet diameter, as cofferdams, in the construction of the Midland Great Western Railway bridge over the Shannon. To this list may be added the new bridge over the Thames from Putney to Fulham, in which the piers will be formed of four cast-iron cylinders 8 feet in diameter, carried to such a depth as not to interfere with the dredging of the river. It is proper to remark here, that other applications of both the screw-pile and pneumatic-pile either in constructions or in experiments, may have been made and noticed in the publications of the day, particularly in periodicals devoted to such and kindred subjects; but as these, in consequence of the restrictions upon the purchase of books, are only occasionally accessible, and then through private sources, nothing is positively known as to the fact.

The objection to screw-piles for founding a work at New South Shoal does not apply—except as to giving them their true relative position—to pneumatic-piles, which, being sunk into the bottom by atmospheric pressure caused by exhausting the air from the hollow shaft, the erection of a fixed structure, such as that required to apply the mechanical power to drive the former, is dispensed with, and the objection to the great length of the pile through which this power must be exerted, at the same time got rid of. But it must not be supposed, that because a fixed structure is not indispensable, a floating body is deemed sufficient for the successful application of atmospheric piles in the present instance. This is not the case. That these piles may be planted singly in favourable weather at so exposed a point as New South Shoal, by well-devised measures fully matured, from so unstable a footing as a floating body, the sinking of the cylinder on the Goodwin Sands is of itself abundantly sufficient to prove; but that the number of piles required to constitute a foundation for a lighthouse or beacon may, under the circumstances, be made to receive their proper relative positions, so far at least as to render them properly available for the intended purpose, is not believed. The manner in which it is proposed to provide against this objection in the use of the atmospheric pile in the present case, or at other points of equal exposure, will be explained in the project now submitted.

Having premised that though a solid structure at New South Shoal, were it possible to erect one at that exposed point, might withstand the direct assaults of the sea, it nevertheless would be overthrown by the wasting of the sands on which it stands, through the insidious workings of the waves acting on the mass, and that to meet the case, it would be necessary to adopt a foundation; which, while it afforded the necessary area and strength to support the required superstructure, would offer no impediment, practically considered, to the motion of the currents or the waves; having also expressed the opinion that works combining these pre-requisites may be founded on submerged soils by means of Mitchell's screw-pile and Pott's pneumatic-pile—and further, that for reasons which it is conceived are indisputable, the former cannot be applied to that use at New South Shoal—the bureau will already be prepared to learn that, as the practical application of the latter is not open to the same objections, it is recommended for the present design.

The instructions of the bureau calling for a plan and estimate for a beacon on New South Shoal are predicated on so much of the "Act making appropriations for lighthouses, light-boats, buoys," &c., approved March 3, 1849, as is contained in the following words, to wit: "For a screw-pile beacon or other practicable structure on New South Shoal, off Nantucket, discovered by the survey of the coast, $25,000, to be expended under the direction of the Bureau of Topographical Engineers." A plan and estimate for a beacon are accordingly herewith submitted. Considering, however, that a beacon would mark the shoal during the day only, and that the risks and dangers of navigation are more imminent and numerous at night, and especially during the boisterous season, when the nights are longest, it has been deemed advisable, in anticipation of the approval of the bureau, to prepare also a plan and estimate for a lighthouse for the same point. In doing this, less hesitation has been felt, because, in the erection of any work at a position so exposed as the one under consideration, the only real difficulty consists in establishing the foundation; and because the greater cost of a lighthouse, although certainly considerably more than for a beacon, bears no sort of reasonable comparison when the superior and continuous usefulness of the lighthouse is considered. It was also conceived that the plan might be so arranged, that in case the beacon structure should be adopted, and should, when raised, be found competent to resist the shocks of the ocean, the project of a lighthouse might be finally executed. In contemplation, therefore, of that ultimate object, the dimensions of the proposed beacon, in general and in detail, have been enlarged beyond what might be otherwise considered sufficient; but whatever may be the excess thus caused in the estimate for the beacon, it is confined almost wholly to the foundry cost of the structure. In other respects, unless the size of the work should be greatly reduced, the expenses, excepting those in which time enters, would remain nearly, if not quite, the same.

As the two structures, as already stated, are in part common to each other, a description of the lighthouse, as the larger of the two, will, with occasional reference to the beacon, be sufficient for both.

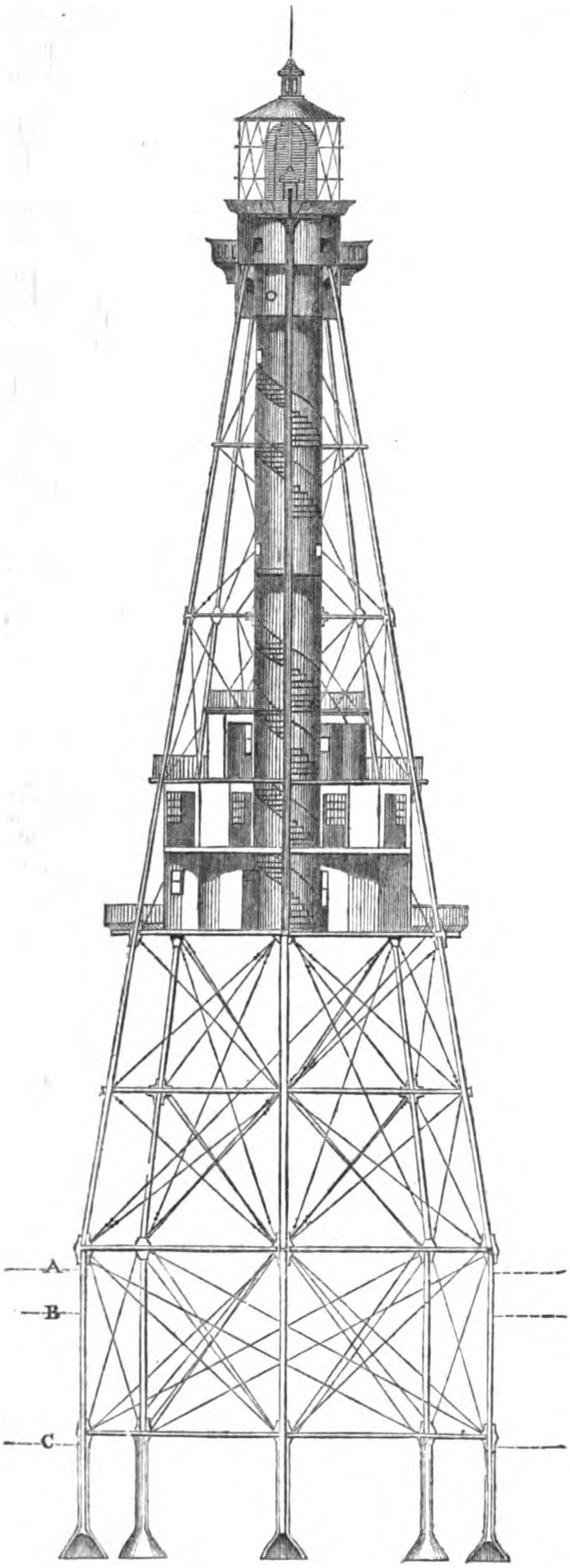
The foundation is composed of iron piles, so grouped together as to form an octagonal prism 50 feet in diameter, and about 42 feet in height. From this prism, as a base, rises a truncated pyramid, composed also of iron piles, which inclining inward 6 on 1, for a further height of 120 feet, fall within the diameter of 10 feet, and are received and secured in a great ring-piece, which, in turn, is surmounted by the watch-room and lantern, making the whole height 185 feet. The piles, one at each angle, and one at the centre of the octagonal prism, are of 12 inches; those of the truncated pyramid in three lengths of 12 inches, tapering to 6 inches. The entire structure, including the prism for the length of the piles, is braced horizontally in seven planes, and diagonally between every consecutive two of these planes, except where the dwelling of the light or cage of the beacon, as the case may be, interferes, when these are in part omitted. The dwelling stands 40 feet above the highest tides, is composed of three stories of 9 feet each, and communicates with the watch-room and lantern above by a spiral stairway in a column of wrought-iron 8 feet in diameter. The two lower stories are 30 feet, and the upper story 20 feet in diameter; the first and third stories, as well as the roof of the dwelling, and the watch-room and lantern, being surrounded by galleries. The watch-room and the lantern are 12 feet in diameter; the former 6 ft. 9 in. in height, the latter about 12 feet, with the roof and ventilator, &c., 20 feet in height. The beacon occupies but two of the three lengths of piles forming the pyramidal frustrum of the larger structure. The cage, the bottom of which is elevated 60 feet, and the extreme top 108 feet above the level of the highest water, is composed of columns arranged in the form of a cylinder, 24 feet in diameter and 24 feet in height, surmounted by a canopy, giving it a further height of 24 feet.

These are the outline or main features of the two structures. The details will be better understood from the drawings communicated herewith, than from the most lengthened and minute description. They consist of an elevation and vertical section of each work on a scale of 4 feet to an inch ($\frac{1}{48}$), and sixteen sheets of details on the same, and double the scale; and will show, not only the manner of bracing proposed, but also the character of the cage, the arrangement and finish of the dwelling, and passage thence to the watch-room and lantern of the latter; and also the arrangements for securing the boat for taking in stores; the position of the fog-bell; the keeping of the oil, water, and fuel, &c.. &c.; and all other particulars, even to the size of the material employed, &c. Talbotypes of the elevation and vertical section of each, reduced in scale to about $\frac{1}{152}$, are also appended to the report.

It is now necessary to explain in what manner it is proposed to establish either work on the shoal. It was stated, when describing the applicability of screw-piles and pneumatic piles for founding the proposed structures, that as the latter required no mechanical force to insert them into the bottom, the employment of a fixed staging, from which to apply such force as was required in the use of the former, would be unnecessary; and that although a floating body might, by well digested measures, in favourable weather, be successfully employed in sinking them singly, it would not be practicable to give the number of piles required to found the work their proper relative positions from so unsteady a footing. The utter hopelessness of constructing a fixed platform, under the circumstances, at so exposed a point as New South Shoal, at least by such time in the working-season as to render it available for the intended purpose, was also shown. What other course, then, shall be adopted in the emergency? It is, in my opinion—not lightly formed—to carry out and deposit on the shoal, by one bold measure, the entire lower or foundation portion of the structure described as the octagonal prism, and by Dr. Potts's process, so simple in its character and wonderful in its results, to sink it in the sand to the required depth. It will not escape attention, that in taking this course, the necessary bracings, down to the very level of the shoal, will be secured to the work; whereas, in putting down the piles separately, the attaching of them is barely possible under the most favourable circumstances, at so exposed a point.

The foundation or lower portion of the structure, already in part described, is formed of nine piles, occupying the angles and centre of the prismatic figure, bound together by two sets of horizontal braces—one 20 feet from the bottom, the other at the top—and by three sets of diagonal braces between these planes. It is necessary to state here, that the lower part of each pile is received by a cylinder having a conical base or foot, through which, by a separate pipe, provided for the purpose, extending to the top of the framing, it is designed to excavate the sand by the pneumatic process. By this arrangement, the advantages of the two systems—of the screw-pile and the pneumatic pile—have been combined; the means, on the one hand, by which the soil may be penetrated to the required depth, and the use, on the other, of a shaft, presenting, with a proper bearing, the least exposure, strength considered, to the action of the sea. For the character of this arrangement, and for all other details, reference is respectfully made to the model of the foundation section, on a scale of $\frac{1}{24}$, which will be deposited in the bureau. The work, as designed, including the cylinders with the conical bases to receive the solid piles, and all necessary appendages, such as air-pump and receivers, and air and sand piles, &c., &c., for sinking it into the bottom, weighs 238 tons. To receive and float this great weight, distributed as it is throughout such large bounds, will require twin-camels, each at least 100 feet in length, 15½ feet beam, and 10 feet depth of hold, or say about 160 tons. These camels, when light, will draw little over 3½ feet water; and when loaded, about 7 feet. Carrying the foundation as proposed, with the lower set of horizontal braces resting on the rail, the cones or shoes of the cylinders will extend nearly 4½ feet below the keels. In this same position, 61 tons of the weight will be suspended below, while the balance, or 177 tons, will stand above the rail. It will be time enough, should the present design be approved and ordered to be carried out, to digest all necessary details, to insure a full efficiency to the camels; to determine whether they shall consist, as now proposed, of two similar vessels of the ordinary model, or of two having, when combined, the general outline of a single vessel; the most perfect way of securing them to each other, and to their burden; the best arrangement for towing, mooring, and flooding; and, finally, the proper mode of removing them from under the framing when it rests in position on the shoal. It is even now evident that it is desirable so to modify the lower framing that a larger proportion of the weight may be carried below the body of the camels than the present arrangement provides for. Again, it further appears, as far as experiments with the model may be relied upon, that to insure the uniform descent of the foundation, it is necessary to have either an air-pump for each pile, or, if one air-pump only is used, to communicate with the soil-receivers by air-pipes of equal lengths. The weight on each pile, when resting on the bottom, is 26·2 tons, which distributed over 19·6 feet, the area of the base of the cones, 5 feet in diameter, gives 1·33 ton for each foot. The entire weight of the lighthouse structure is 640 tons; of the beacon, 466 tons; giving 71·1 tons on each pile, or 3·6 tons on each superficial foot in the case of the first, and 51·6 tons on each pile, or 2·6 tons on each superficial foot, in the case of the second work. To sink the cylinders 19 feet in the sand, the depth proposed, will require the raising in each case of a column of sand of that height, 5 feet in diameter, or 373 cubic feet, or about seven times the contents of the receivers, calculated at 54 cubic feet. As there is, however, a large admixture of water with the sand, raised by pumping, the descent of the cylinders will necessarily call for the filling of the soil-receivers much more frequently.

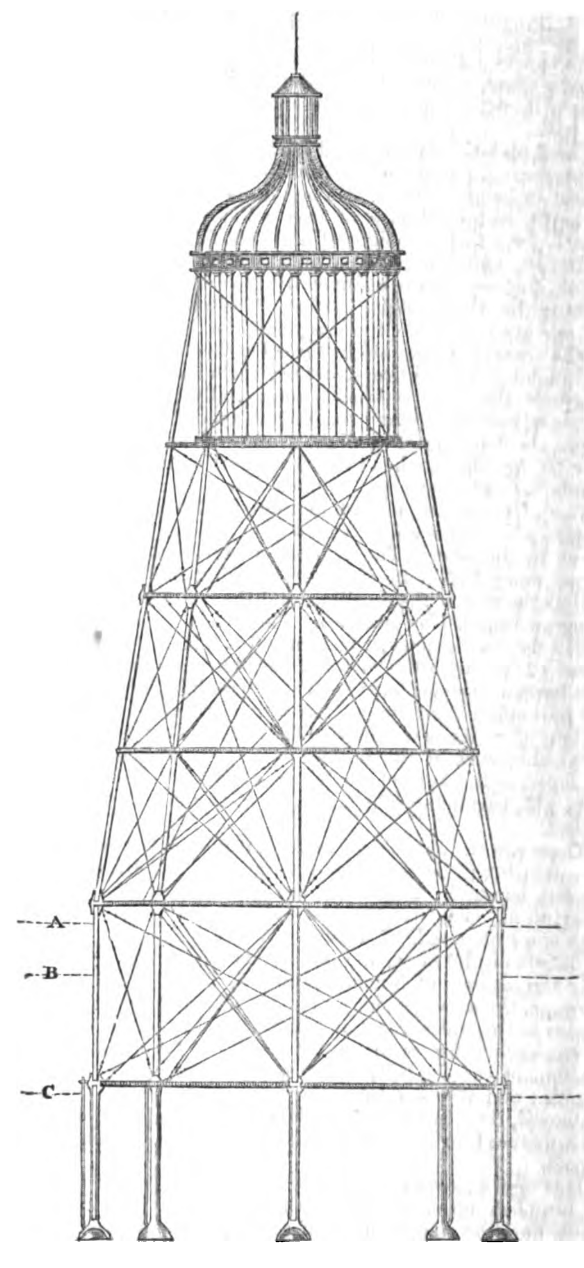
In recommending the carrying out of the foundation in one body to the shoal, the hazards which belong to the entire proceeding, from the departure of the camels with their burden from




SECTION OF PROPOSED NEW SOUTH SHOAL LIGHTHOUSE.

A, High-water Line. B, Low-water Line. C, Surface of Bank.

the selected harbour, to their arrival, and the complete establishment of the work at the site, are, it is believed, in no wise underrated. So far from this being the case, it is not improbable that, by dwelling on the subject, I may have rather magnified them. The towing the camels in a sea-way with their load, a large portion of which is, on the one hand, high above their decks, and on the other, far below their water-line; the placing, and then securely mooring them at the selected site; the flooding the camels, and then relieving the foundation, on resting on the bottom, from them, without injury from the heave of the sea to either, particularly the former; and, lastly, the sinking of the piles by the pneumatic process, are all operations, under the circumstances, of much delicacy, liable to great risks, and, as a consequence, involving the issues in much uncertainty. The velocity and ever-changing direction of the currents at the site, and through the group generally; the exposure, and the distance of the shoal from the land; and, above all, if it be possible to draw a distinction where each controlling condition holds so important a place, the distance of the point of destination from




SECTION OF PROPOSED NEW SOUTH SHOAL BEACON.

A, High-water Line. B, Low-water Line. C, Surface of Bank.

a harbour, all go to show that the difficulties and dangers of the operation are of no ordinary character. As its success depends on the vicissitudes of the weather, that is the true turning-point in carrying out the final design. But in making these observations, I desire also to say, that, in my opinion, the question is not, as in most cases, a mere selection from several plans, but is reduced to the alternative of adopting the plan now suggested as the only one that has a chance of success, or the entire abandonment of the design, to mark the position of the dangerous shoal in question.

The plan of operations for the erection of the lighthouse calls for four and a half years, thus distributed: one year and a half in constructing and setting up and taking down the work at the foundry, and transporting it to the selected harbour of refuge and departure; the first season at the shoal in establishing the foundation section at the site: the second season in raising and bracing the pile-framing, and forming the iron work of the dwelling, &c.; and the third and last season in finishing the interior of the dwelling, &c., completing the lantern, and setting up lighting apparatus, constructing hoisting-davits, &c., putting up fog-bell and striking-machinery, water and oil-tanks, &c., furnishing, painting, &c., and lighting. The plan of operations for the erection of the beacon covers three years, employed as follows: one year at the foundry in forming structures, &c.; the first season at the shoal in fixing the foundation section; and the second and last in building up and bracing the framing and forming the cage, &c.

Conceiving, as already remarked, that the placing of the foundation constitutes the main obstacle to a successful issue to the proposed project, a description of the operations to carry it out will be confined to an outline of what would probably be the course in regard to that measure. It is necessary previously, however, to state, that although there is as little as 8 feet at low water on the shoal, and an area of considerable extent within the two-fathom curve at the same stage of the tide, it has been thought advisable to design the work for a point in a depth of 14 feet on the land-side, and midway of the length of its crest, which standing in the relation somewhat of a breakwater, will afford a partial protection to the work against the deep-sea wave. It should also be stated that as Nantucket, the nearest harbour to the shoal, has but 6½ feet at low water at the entrance, Edgartown, the next nearest, with 15 feet at the same stage of the tide, is selected as the harbour of departure and refuge in the proposed undertaking.

The precise site of the work on the shoal having been marked out by disc-buoys, having mooring anchors laid down, &c., and the double section composing the foundation put together on the camels, a favourable state of the weather, with the wind offshore, should be taken to set out from the harbour—so timing the departure as to reach the shoal, distant, as already stated, forty-two miles, by the dawn of day. The time required to make the trip will depend, of course, on the speed at which the steam-tugs can tow the camels with their burden. This will probably be found to be somewhere between three and a-half and seven miles per hour; but this point should be settled previously, by one or more experimental trips off the mouth of the harbour. These trials may also be found necessary to ascertain how the camels carry in a sea-way, so as properly to adjust the burden on them, &c. As the draught of the foundation structure, as carried on the camels, is less by 2½ feet than the depth at low water at the point at which it is proposed to found the work, the arrival at the shoal need not be governed by the stage of the tide, though high-water is preferable, as all other conditions being the same, the swell of the sea, in consequence of the greater depth is then least. Having arrived at the shoal, the operation of depositing the foundation at the site is one which, in case the weather continues propitious, should require but little time to accomplish. As the plan of the work is based on a regular figure, and may consequently take any position relatively with the shoal, the steam-tugs should tow the camels into place on the direction of the current as it then runs, when the anchors will be let go, and the other appliances prepared for the purpose put in requisition, to moor them as immovable as the circumstances of the case will admit. The next proceeding in course is to flood the camels, and bring the foundation on the bottom, when the former may be drawn by the steam-tugs from beneath the latter. A full and well-instructed force, already occupying the work, will then commence sinking the structure by the application of the steam air-pump, by excavating the sand under the piles through the tones forming their feet, and continue vigorously to prosecute the operation until it descends to the required depth. Twenty-four hours of favourable weather, would, it is confidently believed, suffice for the complete and satisfactory accomplishment of this most novel proceeding; and even half that time to place the work in safety on the shoal against any ordinary contingency of weather, in case the state of it at the time should prevent the sinking of the cylinders. The great breadth of the structure compared with its height, and the absolute regularity of its figure, combined with its enormous weight, and the smallness of the surface exposed to the blow of the sea, all go to warrant a confidence in this belief.

Estimates for the light-house, as well as the beacon, accompany the report. They consist in each case of a synoptical estimate under distinct heads, with references to corresponding subordinate estimates, running much into detail.

It has been earnestly desired, by tracing closely the probable course of the operations, to arrive at the true cost of carrying out the designs submitted. No exigency that seemed likely to arise has failed to be noticed and provided for; and hence the opinion is confidently entertained, that either work, if at all practicable, may be executed for the sum set down for it. It may excite surprise that this assurance should be given, when the aggregate in either case is so large. But when the position and character of the locality, and the extraordinary circumstances under which the operation must be carried on, are fully understood and fairly weighed, this feeling it is believed, will give place to a fixed conviction, that though made up from data as full as the nature of the case would permit, they in no wise exaggerate the probable cost. That the large expenditure called for to consummate the more complete design of the two would be justified by so large an expenditure as that named, the valuable interests that would be subserved by it, as set forth in part in the present report, it is presumed, will generally be admitted.

Of the three great light-houses, Eddystone, Bell Rock, and Skerryvore, the last only was built after the introduction of steam navigation. Mr. Alan Stevenson, the engineer, in his account of the construction of the Skerryvore, says: "From the extent of the foul ground round Skerryvore, and the absence of good harbours in the neighbourhood, it was foreseen at the outset that the operations of landing 6000 tons of materials on the rock could not be accomplished by means of sailing-vessels, with that degree of certainty and regularity which was desirable, in order to obtain the full benefit of the short working-season which the climate of the western Hebrides affords, and the necessity for providing a steam-tender was therefore generally admitted." Again: "The use of a steamer at the very outset of the works would doubtless have proved of the greatest service in the erection of the barrack on the rock, and would have materially lightened our cares and toils; but I am not sure that I should have acquired so thorough an acquaintance with the difficulties and dangers of the Skerryvore, or that I should have been so well prepared for all the obstacles that presented themselves in the after parts of the work, had the first season's operations been conducted under those advantages which are always derived from the use of steam-power. As it was we had much to bear from the smallness of the light-house tender, named the *Pharos*—a vessel of 36 tons, new register—which was all the regular shipping attendance we possessed during this first season; and the inconvenience arising from her heavy pitching was, to landsmen, by no means the least evil to be endured. But the frequent loss of opportunities, of which we might easily have availed ourselves if we had possessed the command of steam-power, and the danger and difficulty of managing a sailing-vessel in the foul ground near the rock, and between it and Tyree, were, perhaps, even more felt by the seamen than by the landsmen; and if the experience of a single year's work can form any ground for an estimate of the length of time required for building the Skerryvore light-house with a sailing-vessel, I should say we must still (even in 1845) have been engaged in the masonry part of the work, which was finished on the 25th July, 1842." The steamer employed at Skerryvore was of 150 tons, with two engines of 30-horse power each, and cost completely fitted (5930*l.*) $29,650. An alteration in the engines by raising the shafts, &c., increased this (423*l.*) $2115. Repairs on the hull and engines during the progress of the work (1057*l.*) $5285. Sailing expenses (6001*l.*) $35,005, or for each of the four years, 1839 to 1842 inclusive, $8751. This includes, it should be remarked,, coals supplied the different departments of the works, and also the smiths' forge.

If, according to Mr. Stevenson, the employment of steam was a matter of economy in time, and, as a consequence, in money, in the operations at Skerryvore, with a harbour of refuge comparatively near at hand, and after the first season a barrack on the "rock" for the accommodation of the workmen, it will not be denied that even a greater pecuniary saving would follow from the employment of the same auxiliary in the operations at New South Shoal, a point 20 miles from the land and 42 miles from a harbour, and no footing on which to establish a residence short of the final structure. The principal duty of the steamer at Skerryvore was to tow the vessels carrying the 6000 tons of stone forming the structure. At New South Shoal the call for transportation, even for the larger work, would be but 640 tons of iron, including the 238 tons proposed to be carried out in one body in the foundation. But, on the other hand, it is necessary to provide a residence for the workmen at the shoal, a position at which can be held not only longer, but be more promptly re-occupied after a storm—the very time, too, when the weather is generally most favourable—by means of steam. A receiving-steamer is accordingly provided for; and that she may not be obliged to leave her station except from stress of weather, a steamer of the smallest class considered safe, to ply as a tender between the shoal and the shore, to carry materials, provisions, water, &c., &c., is also added. These steamers should be propellers, which, besides being less costly to build and to run, are more roomy and have flush decks and sides, and hence better adapted to meet the exigencies of the required service.

Although the range for an elevation of 137 feet (the least height by the design of the focal plane above the level of the sea), and the deck of an ordinary size vessel, is quite within the powers of the second order of lenticular lights, it is deemed advisable, in view of the importance of apprising navigators of the position of the shoal at the earliest moment, to provide in the estimate for one of the first order, which by the increased volume of light may not only be seen under a less favourable condition of the atmosphere, but also be distinguished aloft from ships of the largest class when actually below the horizon. The difference in the first cost of the two orders is about $3000, the difference in the maintenance about $350, annually—confined in the present instance, from the character and isolated position of the light, requiring no larger force, to the greater consumption of oil—say 250 gallons—and the slightly increased cost of the smaller accessaries.

I have been assisted in the preparation of the designs of the two works by Mr. William Dennison, of Boston. Besides very many of the details, the arrangements by which the piles are received in the great ring-piece which encircles the stairway cylinder, thus giving them the character of reciprocal tension braces, and the tapping of the cones at the base of the cylinder-piles, through which and a separate pipe the soil is raised, thus admitting of introduction of the solid piles into them before being inserted into the bottom, are both due to his intelligence. The drawings were also made by him. It will not be expected that the details shall not, to some extent, require modification. These it will be time enough to consider and make on the preparation of the necessary working-drawings in case it be determined to carry out either. The propriety for some changes is even now apparent: among these, for instance, the reduction of the weight of the great ring-piece just mentioned, as far as may be compatible with proper strength, and the removal of the soil-receivers and their pipes within the area of the base. Neither is it at all improbable that further investigation and reflection may induce a change or reduction to some extent, or both, of the diagonal bracings, which, by their number and near approach to each other, may cause the ice to form, particularly in the series just above the level of the sea, in such masses as to endanger the safety of the structure. At present these braces are of three kinds: one set in the faces of the octagonal prism or truncated pyramid, as the case may be, called in the estimate *panel;* another set in planes, whose horizontal projections are as radii of those figures, called *radial;* and a third set, forming an endless rod, taking hold in succession of every third pile and alternating between two consecutive series of spider-web bracings, called *chord*—these last serving both as tension and torsion braces.

Besides the plan already noticed, I beg to call attention also to a small tripod beacon designed to be thrown entire on a shoal. The feet are formed of inverted cones, having discs increasing in size upwards, and so inclined as to be parallel with the horizon, which there is good reason to believe would, under the action of the currents and the waves on the sand, sink not only uniformly, but sufficiently deep into the bottom to give the work, from the small exposure of the superstructure to the same action, the necessary stability. As it is with a view merely to call attention to a measure that may possibly lead to future useful results, and as the present plan is not free from serious objection in the details, no estimate either of the weight or cost has been prepared. The entire height of the beacon above the water is about 70 feet; the size of the cage 17½ feet by 8½ feet.

While on the subject of establishing sea-marks by so summary a process, I trust I may be excused for suggesting the trial of disc-buoys to mark to some slight degree of usefulness the principal shoals off Nantucket. These buoys have been used by me in hydrographical surveys now for some years with the most satisfactory results; among the last occasions at the Tortugas, where, though but of 100 lb. in weight and 21½ inches in diameter, and with a wooden staff, they stood immovably on the outer side of the reefs, exposed to the roll of the sea from the Gulf. Buoys for the experiment should, with the same general form, have greater weight—say 250 lb. to 500 lb., with a tapering iron staff, or one of round iron of diminishing sizes, properly coupled, and surmounted by a flag attached to a light iron, vane-like frame. The first cost of a buoy such as described of 250 lb., would not exceed $25; of 500 lb., about $35. A tracing of a buoy of this kind, with a disc of 500 lb., is forwarded herewith.

In addition to the drawings and papers already mentioned, a coast-survey sketch of the Nantucket group, scale $\frac{1}{400000}$; a coast-survey MS. tracing of New (Davis's) and Old South Shoals, scale $\frac{1}{40000}$; coast-survey charts of Nantucket, Edgartown, and Holmes's Hole, and a chart (Blunt's) of the coast from Absecum Inlet to the Penobscot, showing the general contour of the coast and the relative position of these harbours with New South Shoal, are also forwarded, as necessary to a proper understanding of the report.

I beg to make my acknowledgments to Professor A. D. Bache, Superintendent of the United States Coast Survey, for copies of charts of Nantucket, Edgartown, and Holmes's Hole, and of a sketch in part (MS.) of Nantucket shoals, and for information in reference to them, used in the preparation of the present report. I am likewise indebted to him for facilities, through the steamer *Bibb*, engaged in laying down the group, to examine New South Shoal; and also to Lieutenant Commanding C. McBlair, of that vessel, and his officers, for their attention in furthering the object of my visit; and likewise to Lieutenant Commanding McBlair, for a copy of the weather-journal of the *Bibb* for 1847, 1848, and 1849. It is proper I should also express my acknowledgments to the several collectors of the customs of the ports named in the statements herewith, for their prompt response to the call made on them for the commercial statistics they embody.

The delay in the presentation of this report was occasioned, in the first instance, by other and more pressing duties; and since then, by the time required to prepare the model, drawings, (including the estimates), and to obtain the necessary commercial information which accompanies it.

HARTMAN BACHE.
*Major Top. Eng, Bvt. Major.*

*Office of New South Shoal Beacon,*
*Philadelphia, Dec.* 27, 1851.

[Next month we purpose giving the synopsis of the estimate; the estimate for lighthouse; the estimate for beacon; detailed estimate for materials and labour of both lighthouse and beacon; estimate for patterns and pneumatic apparatus; &c.]

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*Mr. Samuel Phillips.*—This gentleman, the editor of the 'Hand Book to the Crystal Palace,' died suddenly at Brighton, on the 14th ult., from hemorrhage of the lungs, in his 39th year. Mr. Phillips was a well-known writer in *Blackwood*, the *John Bull*, *Morning Herald*, and other Conservative publications. He had been long suffering from consumptive symptoms, but resolutely persevered in his literary labours to the last. The readers of *Blackwood* are probably aware that to Mr. Phillips's pen they were indebted for 'Caleb Stukeley,' a tale abounding in powerful passages, and displaying genius of no ordinary character. To the *Times* it was generally understood that Mr. Phillips contributed those literary critiques which usually enriched its columns in the winter season. Their greatest merit was the masterly analysis they presented of the mode in which authors produce their effects. In this species of exposition, Mr. Phillips had no superior.

## ADDRESS TO THE ARCHITECTURAL ASSOCIATION,

Lyon's-inn-hall, October 6th,

By Thomas M. Rickman, *President.*

In rising to fulfil the customary duty of your President this evening, I address those who, like myself, engage in the study of our art, not merely with the view of passing a lifetime in its practice, but of deriving pleasure from the pursuit, and, as I trust, satisfaction from some future retrospect of progress.

Those of us who are young desire to advance in knowledge, and also, looking at certain bright examples of architects, as well in times gone by as in our own day, we would find in architecture what we see that they have found—that element which shall become a link between ourselves and all the men of higher aim in the pursuit of truth and beauty, and, while we exercise a calling inseparable from the regular routine of business, shall prove an element enabling us to feed that taste, which, dependent principally on what is set before it for character, is yet possessed of an elective faculty that finds charms in the really beautiful unequalled by any other attraction.

Those who have passed through our stage of study will remember that there was in such aspirations a pleasure which was a relief to their more studious hours, and, while proving a recompence to their labours, became at the same time an incentive to continued exertion.

The present, however, is not the time to address a meeting of the rising members of any profession on the mere sentiment of their occupation. I have no hopes of impressing on the mind of any (if such there be) insensible to beauty or truth, the fact that such exist; but I would call to your remembrance, that all the beauty which is admired for its own sake has a common origin, whether it be the chisel, the square, the pencil, or the pen, that is the instrument employed; and that all the truth which the refined eye or the simplest taste can appreciate, whether it be marble, stone, canvas, or language, that conveys the impression to our senses, is but a reflex through the mind of man of eternal truth, of which all nature bears the impress.

We are all engaged in the study of an art whose practice has, like humanity, its bright side and its dark one, and doubtless our tastes will be shown by the line of study we adopt. We study, for it is our business; and we make our business our pleasure, for we love our art. At the same time, there is another class who study architecture, with whom our relations are somewhat perplexed—the critics. With more or less knowledge of the value of particular instances, they generalise. Their position is not that of our enemy, for they diffuse a love of the art; nor is it that of an ally, for they turn upon us, till in each case they are better informed of the faults, not of ourselves alone, but also of our clients; proving once more, that a little knowledge possesses at times dangerous qualities. Yet are there many among them who have great taste for the art, and can give upon occasion most serviceable hints for our consideration. They shine, however, most when, in criticising a building, they lay open the secret workings of the architect's soul in the design. They ofttimes use an architect's work as a phrenologist would his head, and, judging by their own standard, detect the moral, intellectual, and other faculties which he may possess, thereby causing at times some amusement both to ourselves and others. Are we not, however, responsible in the first instance for the opinions which sound critics may entertain of our work? And may not the reasons which may seem to them to have influenced our mind, have had in reality some effect in directing our design, though other matters at the time had turned our thoughts into a much more tangible form? The most important of architectural criticism has been generally that based on historical principles. The character of architecture is a reflex of the age, and ever has been. There are many circumstances in the position of an architect, which render him the best exponent of the character of his time. He is the tool of the men of power. His own nobility of soul he obtains from studying the ideal of the age. His means he derives from having the good opinion of its leading men. Yet is it in his power to render to posterity the nobility of feeling which he sees around him, or not. The characteristics of his age he must, however, import into his work; and his originality must arise from the fact that some great thought is to be found at work, a witness to the age. This, with the aid of the sister arts, specially sculpture, he finds he must make his own, and to it, even unconsciously, he gives that expression which shall for the time more firmly imprint its footsteps on the public mind, and to future ages more clearly depict its course. Thus, whether it were permanent dynastic power, or acquired power of conquest, that was to be exhibited and adorned, the Egyptian or Assyrian architect devised that arrangement, and gave that expression to his work, which we still recognise in the repose of the temples and tombs on the banks of the Nile, and in the life and action of the palaces on the Tigris. Again, whether it were the refinement of independent mental cultivation, or the amount of conquered wealth, that guided the architect in his designs, on the Acropolis every device was used to produce simplicity of general effect; among the Seven Hills every feature of the building was obliged, beside fulfilling its structural duty, to carry so much ornament as its surface was capable of receiving. Nor can I avoid carrying a comparison into our own architectural styles; for as the grand principle of superposition which gives meaning to all Classic architecture, and is still the cause of much of the beauty of early Gothic art, so was the earlier philosophy, a sound course of reasoning, though carried on by a very few, whose works, or rather whose scattered sayings, still remain the key to our present knowledge. And as that other architectural principle so captivating to the eye—the continuity of line—rose with the ascendant ideas of the art, and gradually overcame all other characteristics, so that in all later Gothic this is still to be found the leading idea, so was the superficial study of the dark ages; for, while destroying the vitality of true philosophy, as of the Gothic style, both seemed, in the perverted view of the time, but the legitimate consequence of their principles.

Now, though we may admit the accuracy of a critical judgment as to the character of an age from that of its buildings, yet this is not the criticism we wish; nor are they the peculiar qualities, good or bad, of those who have provided the necessary funds for a structure that we, as architects, value. Critics should have the power of bringing a great amount of knowledge to bear upon architecture, a knowledge gleaned from extensive study in other arts; and they should find in the principles of construction and of ornamentation which we adopt, truth and beauty analogous to those of other arts. From an article in the 'Quarterly Review,' on Mr. Knight's work on Italy (for March 1845), I may draw an illustration of my meaning. There is towards the end of its pages an illustration of the relation of the structural, formative, and pictorial branches of our art, by reference to the skeleton, muscles, and surface of the human anatomy, which is well worth the attention of the student. It brings to view the true position of architecture, as capable of embracing and expressing in the simplest form the greatest truths—those, namely, of relation. To express these relations of form, colour, cause, and effect, appear to me among the highest aims of the architect; but while, in the one case, unless the client's hand is liberal, nobility cannot be expressed by the building, so in the other, unless higher studies occupy the architect's attention, unless he derive a pleasure from the contemplation of something in nature other than its mere surface, unless his reading and his thoughts be elevated above those of his fellows, unless his aim in life be that of the highest standard, it is impossible that his works should embody those relations and contain those higher principles which he may in his brighter moments recognise in the works of the great architects; erections, which have served to place the perfect arrangement of straight lines, and of most formal curves, on a par with the works of artists who, with their all-embracing pigments, chiaro-scuro, colour, or the press, can bring into relief at will every sentiment, every scene, and all the knowledge which the memory of man can contain.

But in the present day, is it possible for the architect to devote his attention to the mastery of these higher relations? How much time must he not devote to the examination of materials and their qualities, and to the study of styles and their characteristics! Where is he to find opportunity for the examination of all buildings by reference to abstract ideas? Each must in this matter judge for himself: I can only bring forward such reasons as seem to me inducements to the study.

The position of this knowledge of materials is not that of the object of study. The comparison of styles is not, even in his own works, the aim of the architect; nor does the use of the material and the class of minor form best adapted for its disposition, constitute the object of his practical efforts. They correspond but to the grammar and logic which are adopted either by natural refinement or by education, either with or without special study of their technical rules. The abuse of a material, or an anachronism in style, gives to the architectural eye as much pain as the breach of a grammatical rule or the adoption of a non-sequitur in a discourse does to the ear of an attentive listener. Again, accidental irregularities in a curve, or deviations from a right line, which occur in a building, offend, as do false quantities in poetry, or discords in music; and the improper ratios in the features of an order are as detrimental to the effect of a design as would be an inappropriate development in a piece of sculpture. These, and many other instances that might be adduced, tend to show, in the several arts adopted by man to exhibit his advancing taste, what are the parts which harmonise the one with the other; and we shall be led to believe that these analagous contrasts and likenesses tell of a relation subsisting among them all; and to contemplate an all-pervading principle, first in nature, then in our treatment of art; a connection elevating to our view of the former, honourable to our appreciation of the latter, and which presents itself as akin to something of a higher character in our constitution—and for this reason: the different arts tell of the diverse forms under which the mind may assimilate the truth and beauty of nature; and since a work of art does not only represent, but also contains some of these beauties, the unity of nature must lead to an unity in all art labour.

If, then, economy of material and accordance with fixity of style are not the great objects of our study, and hence not our legitimate weapons, what *are* the means at our command which may enable us to express the thought of art, to represent those qualities of nature in which we find greatest delight? and thus to take our stand among the poets, or, to give the word its most extensive meaning, the makers of all ages.

Our materials are matter in any form we may choose. We have to think the thoughts we wish to communicate, and we have next to devise means for their communication. The first set of thoughts unites our minds with all that is noble in mankind, the second confines our attention to the study of our materials and of the works of preceding architects; and as ideas elsewere are valueless till expressed in appropriate language, so in our art we cannot separate the idea from the form of its expression. Hence that constant study which is requisite of the orders and styles which have been at different periods the current language of architecture; on these the architect dwells for the knowledge of a language, and the connoisseur for the sake of the thought they convey to his mind. Our thoughts are not all to be obtained from art, but we must endeavour, by that study of whatever we find true or beautiful, to fill our own mind therewith, so that its expression shall be our natural action.

The architect studies art for his own use—he opens his mind to the Cosmos for his own time and for succeeding ages.

Now, as all language expresses action, and our language is composed of materials, so all we do must tell of the action of which materials are capable, that is, motion. All our forms are those of motion, simple or combined. In practice the simplest forms are those always used. If we refer to nature, it is only on its grandest scale that this simplicity is visible; and even then it is so veiled in a complicated relation of masses, that not till thousands of years had rolled over the heads of attentive examiners of the heavens, one, devoted to the pursuit of astronomy, led on by some higher appreciation of the beauty of nature, detected the existence of the ellipse in planetary motion; nor was it till hundreds of years later that the simplicity of that very curve was exhibited, by proof of the intimate connection of the conic sections in all their qualities. Yet are the beauties which Kepler and Newton have found in the simplest curves present in all our works, and though our thoughts may be straying far enough from such abstract considerations at the time when we adopt them in our designs, yet are those causes of force and motion which retain the unity of orbitual progress reflected wherever we use a curved line, and are one cause of the pleasure we derive from their form, so far as it is a reasonable sensation. As, then, the test of comparison for languages is the form of stating an event, the connection between the subject, the object and the verb, so may we use for our comparison of architectural styles the form of expressing motion. In the Classic order we find this most simply expressed, first, in the entablature, column, and pedestal; and secondly, in the column itself: the cap, collecting the weight of the entablature, the subject; the shaft, conveying the weight to the base, which, as it distributes it to the lower part of the structure, represents the object. Now, though we may not find in the other styles so simple a statement of their object, from the character of action being different, yet may we trace this intention, the conveyance of force upwards or downwards, tangentially or normally, in every moulding which the designer has carefully studied for the position which it has to occupy in the building.

Let us see to what extent this is also found to be the case in those branches of natural form which are said by various critics to have been adopted by architects as the basis of their art.

The form of the human body has been adopted by various authors as the exemplar of proportion and symmetry. Here, every part expresses preparation for action: the arrangement of the lower members, ready to convey the superincumbent weight; the arrangement of the joints throughout, so that long-continued vibratory motion can take place without producing any jarr in the frame. These are instances of a like kind to those we have so often practically to study, while every portion of our frame is fraught with means for its proper movements. The relation of the parts tells of their proper occupation, and their symmetry tells of that arrangement which masters all their complicated functions.

Vegetable forms have been adopted by some as the origin of architectural form, and the imitation of them has ever been one great source of beauty in our works. Are these forms not, many of them, clearly attributable to the action of their growth? The increasing weight of the flower and fruit acting on the lengthening stalk, effects its gradual curvature; the varied strength of the different parts of the leaf, and the arrangement of the masses, tend to the curved form of their profile; indeed, the very growth itself is an action of force: and whether we look at that original action, or on the force of gravity acting on the substance of vegetable form during its growth, we still see in this kingdom of nature the clearest exponent of the laws of force and motion.

The pure geometry of lines and angles, as supplied by the mineral crystals, has led many to dwell on the natural superiority of regular forms for conveying an impression of grandeur to the mind; since here we see most clearly exhibited the power of ratio and proportion, as, whatever be the geometrical qualities of a figure, superficial or solid, these it retains, however varied the value of the modulus,—true representative of the strength of that fancy which has induced many to value figures, and forms, and objects, for a symbolism which they have discerned under their surface.

I trust that I may not be considered fanciful while comparing the forms of art with those of nature, with special reference to the actions which they represent, if I refer to certain qualities inherent in the forms we have been considering.

In mineral form the action is all past, the cause of its progress has passed away, and the law of its movements is to be learned but by its results; while in vegetable form, it is its present action, its present growth, that gives us pleasure—the capability of a stalk or stem to support a mass incomparably larger than itself, and that because of a present life which it enjoys, a life untrammelled by rules, yet active by the agency of law. And in the animal form the adaptation is for a future and external work. The modus of its formation we cannot divine; the arrangement of its means of action are hidden from our sight. Its beauty is its possession of powers to act upon other objects. The elasticity of its surface is that of the dormant energy of every member waiting but an inducement to exercise its special function.

Here, then, are some of those truths of natural form which the architect can use. Thus may nature be found a standard with which to compare our art. In this study we shall judge of details from internal evidences, and not from adventitious circumstances; chiaro-scuro will take its place but as an alembic, a means whereby form is made known to us, not as an object for our contemplation.

So far, we have considered only the mental pleasure that the purpose of architectural form is capable of affording us. And what if it should be maintained that the use of colour is also a means of conveying pleasure more immediately through the senses, but still owing its intensity to the purpose displayed in the colour? Would the proof of this point not lead us to value the beauties of nature more highly than by looking at colour as with reference only to colour? For a long time, colours were thought of but as so many separate substances of pleasing texture to be applied to a surface. Then it was found that colour was but decomposed light, and colours were counted seven. Now, we count three colours and their compounds, and we study their mutual relations and the laws which govern their harmony and their contrast, strongly akin to chemical laws. But will the study under this aspect exhaust the interest we derive from colour?

I believe not; and that when we know thoroughly their relations, we may so study the separate colours as to apprehend something intrinsic in their beauties, and thus make true use of them in the scientific conveyance of thought. And since we see that forms derive not their true explanation from contrast with other forms, but by considering the causes which produced them, the life which is proceeding and the actions they are capable of producing, so in colour may we hope to find a meaning not simply by contrast or harmony with other colours, but in reference to some active proceeding or condition which the study of its peculiarities having once suggested, still recalls to mind.

While artists have used animal and mineral, and, specially, vegetable forms, as exemplars ready to hand of the results which, in architectural form, they were anxious to produce, they have treated these shapes in a great variety of styles, displaying more or less of what we call conventionalism; and the greatest artists have always used much of this modification in their natural forms, thereby calling our attention to some portions only of the beauties contained in the original—those, namely, which are applicable in common to both the substance adopted and that in which the applied form is found. But many designers of architectural ornament seem to think that, in conveying to the mind a more exact image of a natural form, they at the same time fulfil the object of their art in conveying a clearer impression of its beauty. There is, however, one great duty of the artist which is in this manner omitted. There are some talents scattered among mankind of an artistic order; men there are capable of analysing the impressions of beauty conveyed from nature, and of seeing the works of God in an aspect somewhat different from their neighbours. Surely, it is their duty clearly to convey to the mind the knowledge they have thus acquired. It may be that such men will not give to the ignorant eye the pleasure to be derived from more exact copies, but the eye will descend upon the real model, upon the natural leaf, after a study of the conventional, with an enhanced pleasure, an effect worthy of high art.

But, not to detain you too long, I have not dwelt, as my predecessors were wont, on the progress which architecture may be said to have made during the past year. Its advance in some branches has been as decided as in others it has been questionable. Our business, as I take it, is more the formation of a class of students, rather than the assumption of an important position in the profession; and therefore I have addressed myself, as far as my small influence may go, to rest the study of our art on a broader basis. Let us admire the expressions of force, and yet not give ourselves up to mathematics, though we must understand them. Let us love variety both of light and shade and of colour, and use chiaro-scuro and chromatics without being mastered by them. And, lastly, let us value symbolism as one method of arriving at the mind of the architect.

The admission of a symbolism in the parts of a structure, and in the details of its construction, is in favour with many classes. Now, I am not now objecting to the explanations which they give, but they seem too often to have this intention—of forming a study, not upon a broader basis, but accessible only to the initiated, a field whereon they may plant a system of dry facts; instead of, by the assistance of refined analogy, leading us up to a better understanding of the subject. They would show some correspondence between the parts of one science and the parts of another, instead of pointing out that vital principle which actuates both.

If, in the remarks which I have had the honour of addressing to you, a view of form has been recalled to your remembrance different from that mere shape which the material object assumes in the mind and in reference to architectural use, the great importance has been brought before you of the motive of the lines which produce form. If you can, for the moment, look at the three kingdoms of Nature, and see in them the representatives of an action not without a purpose; if you can view colours as emanations, yet for the most part to be understood, from the purity of light; if you will look at conventional form as more expressive of distinct thought than the more natural imitation,—then is there present in your mind a conception of that deeper symbolism which looks at all we see as the representative of something unseen, and which consequently considers all man's mental work, all the operations of our minds, as having for its object, in analysis, the discovery of that inner thing, and, in synthesis—(and, for synthesis, what art so great as our own?)—the demonstration of its connection with external nature.

## ON PLAN-DRAWING, AND THE REPRESENTATION OF THE PHYSICAL FORMS OF GROUND IN TOPOGRAPHICAL MAPS.

By Robert Dawson, late Corps of Royal Military Surveyors.

This kind of drawing has hitherto been regarded in a low light as a branch of art, and accordingly has been practised, mostly, under mechanical methods and arbitrary rules; but, as it requires mental apprehension, and is capable of giving mental satisfaction and pleasure, in connection with natural science,—as well as of conveying much useful information for general demands and purposes,—it should be regarded in a higher and more liberal sense; and therefore it is desirable to bespeak, and obtain for it, the attention and judgment of professed artists, to carry it to perfection. In the meantime, being asked my opinion, as a surveyor and draughtsman, on the subject, I proceed to give it by stating, in the first place, what I think a topographical map is, or should be considered.

By a topographical map, then, I should understand a full-face, *pictural* representation of a place, district, or country, in its natural figuration of mountain, hill, valley, and plain,—with its coast and river boundaries and divisions, and the artificial lines, figures, and tracery belonging to the surface, geometrically described on it;—the whole united harmoniously in one pictural exhibition to the eye. It should be such as to exemplify Dr. Arnold's geographical idea of a country, as recommended in his lectures on the study of history, where he says: "A real knowledge of geography embraces at once a knowledge of the earth, and of the dwellings of man upon it. Let me once understand the real geography of a country,—its organic structure, if I may so call it, —the form of its skeleton, that is, its hills,—the magnitude and course of its veins and arteries, that is, its streams and rivers; let me conceive it as a whole made up of connected parts,—and then the position of man's dwellings, viewed in reference to these parts, becomes easily remembered, and lively and intelligent besides. For the sake of mere beauty and liveliness, if there were no other consideration, it would be worth our while to acquire this richer view of geography." "Conceive only (he says) the difference between a ground-plan and a picture—the mere plan geography of Italy." And then, describing part of Italy by way of example, he calls this, in comparison with a common knowledge of geography, "a giving life and meaning and harmony to what is at present lifeless and confused." "I wished (he says) to give an example of what I meant by a real and lively knowledge of geography, which brings the whole character of a country before our eyes." Now this, I think, a topographical map may do more effectually and gracefully than has hitherto been accomplished or exemplified in the best published maps of the present day.

Drawing, in its application to maps, or plan drawing, is not confined to delineation only, but to the whole expression of form in respect of ground. It is *natural history* drawing of land in full perspective perception—the greatest subject for that kind of description;—and, for its successful accomplishment to satisfy the eye and mind conversant with land in its map aspect, it requires the ordinary graphic qualification of the artist, combined with some knowledge of physical geography and geology, and a clear and perfect mental apprehension of the details of the subject, embodied and harmonised as a whole.

*Pictural effect* in maps is the expression of whole forms, and assemblages of forms to the eye, in one whole imaginative view, which must be taken by appropriate surveying, and drawn with artistic judgment and skill. The drawing will be the same, or a parallel case, to that of bas-relief sculpture in full perspective of the plane surface on which it appears, for land may be apprehended and drawn as a great subject of natural sculpture standing in bas-relief of the surface of the sea; but the apprehension of it must be mental and artistic; and the expression will be in bird's-eye and panoramic perspective of the forms, as they fall directly under the eye. The degree of art that may be used, both in surveying and drawing land in map aspect, is greater than seems to have been thought due to this kind of drawing, and therefore it is not to be found exemplified in the best modern maps, nor are the forms poertrayed in those maps so satisfactory and pleasing to the eye, as the most common natural history drawings of other subjects appear, even in books and prints for popular instruction. Those subjects, it is true, may be more familiar in idea,—better known and understood as objects of the animal and vegetable world,—and may please more immediately by direct resemblance,—and, in shape and colour, may be more attractive. They are also comparatively small subjects, and may be apprehended in single view. But there is an appropriate beauty in the forms of land, contemplated in map view, which a map may express, and which the means and resources of art, in the present day, may supply in a much higher degree than has been hitherto effected.

This higher degree of perfection is required for physiological geography, for topographical description, and for other purposes, professional, economical, and general. It has formed the subject of consideration for committees of the House of Commons, for the Ordnance Survey of Great Britain, and for Commissions under the French government for their national survey; but the principle of natural history drawing has not been proposed by any of them, and though some manifestations of its practical application have been made in England, they have not been carried out to their fullest extent.

The *natural history principle* will require the physical substance, and geological structure and formation of the land to be understood, in order to recognise and express those characteristic indications, which a survey of the land itself would give to the physical geographer and to the painter. To form this mental perception, and to make the drawing after it, is the peculiar and great difficulty of the work; for while in the map the eye embraces the whole field at a glance, it is supposed to travel over the ground, and to be everywhere vertically fixed immediately over every part of it. Geometry must give the guiding points, but the drawing will not be a merely geometrical and mechanical process, though it may admit of, and require mechanical drawing and conventional signs, writing, &c., to be added to it. Yet the whole may be executed in such pictural harmony, as to admit of the map being contemplated as a natural picture to the eye. This seems the proper principle to propose, and the artistic ability to require, for this kind of drawing. Under it, description for all purposes and demands, may be accurately and gracefully executed; and, taken as a rule of appreciation for the best published maps, much will be found wanting to bring them up to the standard.

This will not, however, be thought too difficult a task for the accomplished map-draughtsman to undertake; natural history quality of execution being all that is required, and this is known to employ not a very high pitch of artistic ability. Mountains and hills, in map perspective, are not so difficult to draw in single forms as many other subjects of natural history drawing may be, particularly in oblique perspective; for geometrical perspective is the simplest possible, and, in this respect, presents no difficulty at all of mere delineation. It is the whole expression of a pictural idea—in light, and shade, and colour—that constitutes the artistic difficulty to be mastered.

*Natural drawing* in maps has been objected to, I am aware, as having too much of the painter's art in it, the object of which has been supposed more "to please the eye," than to give, as required in this case of topographical drawing, accurate and useful information; and so, liable to abuse in giving fanciful expression, rather than accurate intelligence; but this is arguing from the abuse of the painter's art, which is no more to be assumed for the topographical describer, than for the naturalist, who has acquired enough of the painter's art to describe his subject, whatever it may be, picturally. The same aims, end, and ability are necessary for both. If it should still be thought, however, and contended, that map drawing of all kinds is necessarily more geometrical than natural, and that neat and accurate delineation is better for it, and more useful, than pictural expression,—it may be answered, that both may be combined, that the eye demands natural drawing for natural subjects, and that it is, in fact, in some way or other, always attempted in maps of this kind; sometimes, indeed, absurdly; sometimes rudely and mechanically; and mostly in defect or exaggeration of nature, and artistic judgment of what is really wanted; yet the attempt which is made, and the demand, growing as it does with experience, and a comparison with the state of natural history drawing for other subjects, seems to show that it cannot be given up, or left uncultivated.

The natural history principle, then, I would propose for the aim and standard of the drawing, and the rule by which it may be appreciated. It cannot be expected that either the geodetical surveyor, or the ordinary land-surveyor, should be an *artistic* draughtsman, though in their proper measure both may add this accomplishment to their respective abilities; yet it seems more properly to belong to the latter profession to cultivate it, than to the mathematical and philosophical ability which is occasionally called into action for geodetic operations. Indeed, the land-surveyor may aspire to the higher branch, perhaps, more consistently than the mathematician and philosopher may undertake the purely practical part of surveying and drawing for topographical purposes; for if the surveyor has talent and industry, he may study and learn to add geodetical surveying to the foundation of his business, as well as topographical drawing or portraiture, so to speak, to its finishing efficacy and grace.

Some geological knowledge of land generally, in its figuration, is necessary to apprehend and understand that of any particular country: the general phenomena which appear in its surface forms; the rising and sinking of land in circular and elliptical areas; its formation under a covering sea, and emerging in volcanic forms out of it; its division by rents and faults; its crystalline and mechanical construction in beds and strata; the shaping and denuding effects of floods and currents, cutting out and exposing its forms and features as we now see them. A map, drawn in advertence to these facts and deductions, must be particularly desirable for geological description and illustration.

M. Boué has shown that "a critical similarity of outward forms, while indicating similarity of producing causes, must also, to a large extent, indicate identity of structure; and therefore, from the external appearance of an unexplored country,"—(and from a map properly representing it)—"its geological structure may be inferred, at least to a certain extent."

"Nature has not wrought after an indefinite number of types or models, but on the contrary, her fundamental types are few, and derived from the action of definite constructive forces on a primary base." This reference to M. Boué is made by Mrs. Somerville in her 'Physical Geography,' 1848.

A great flood over all the northern countries of Europe may be assumed to have acted upon and modified their forms, from the traces of it observed in Russia and Sweden by Sir Roderick Murchison. It may be no less evidenced by the forms and figuration of surface in the British Isles, or perhaps more so, when these have been sufficiently surveyed in relation to this great geometrical problem.

A glance at a geological map of England shows a great curvilinear arrangement of its mineral masses on the east of Wales and Cumberland, which the topographical map, in its description of the symmetrical surface forms, should express comprehensively to the eye. Mr. Hopkins, in his paper on the Lakes District, read before the Geological Society, June 6, 1842, assumes the elevations of those masses to have thrown up the incumbent formations at the same time; hence the ringy disposition in horizontal order, of the mineral masses, and the rib-like forms of their surface structure; the hollows forming the channels by which currents of the northern flood passed over the land in a south and south-west direction. The impinging force of the flood is seen in the coast-like escarpments which front the north, the remarkable figuration of the oolite beds affording a curious example. Mr. Darwin's paper, on the connection of volcanic phenomena and the formation of mountain chains, read before the Geological Society, February 7, 1838, seems to afford ground for assuming that the curvilinear order of figuration in England has been produced by this cause, and that it has been the foundation of coralline rings, of which the oolitic beds are the remains.

A surveyor, seeking to qualify himself for drawing the natural figuration of land in a map, should acquire first, a power of figure-drawing (the human figure) with that truth of form and character which may mark, at least, the physical distinction of natural races. He should apply them to landscape-drawing, in that perspective which approaches nearest to the plan view; and in addition to mere manual skill, in delineation and colouring in relief, he should learn enough of the principles of pictural art for his government and use, and study their application from paintings which furnish examples of expression coming nearest to that for which he wants instruction and guidance. He may draw from solid models, too, which are to be met with in stones, heaps of earth, knots in the stems of trees, the waves of agitated water, and other natural forms which resemble those of land so much, that both are described by a common term of resemblance. Models taken on purpose, and cast in plaster, may be used; but I think natural models, such as I have mentioned, will be suffident, and, indeed, the best. Mathematical solids resembling mountains and hills, as the cone, pyramid, and segments of the sphere and ellipse, with a horizontal plane for their base, may be referred to in idea on the ground, as typical forms, for ready whole apprehension, and nice distinction of the natural forms. A nomenclature for the natural forms of land, founded on their similarity to the preconceived types, will assist the perception of geometrical, under actual perspective, and be of great advantage in description and reference by words.

The table-hills about Bagshot, Chobham, and Farnham, must be familiar to many observers of the late encampment at Chobham; and to some with me, who witnessed that on Bagshot Heath, and the other places south of Windsor Forest, in 1792. The table-hill, divided diagonally by an inclined plane, passing from the higher edge on one side, to the lower on the opposite, gives a wedge-like or shelving form to the lower segment;—its natural type is the running and surging wave; and both are common forms in sand and gravel hills, and other loose earths, from the low shelving banks and beaches of a seacoast, to the highest table and shelving lands of the world. Our *edge* hills, as several are called, besides that of the battle (Edgehill), are of this species. Mountain-limestone hills of the carboniferous system, are bold examples of this form—trap-hills, the silurian and old red sandstone hills, &c. Mr. Nichol describes a range of this kind of hills, extending from St. Abb's Head to near Port Patrick, in his paper read before the Geological Society, January 1848. "The most remarkable physical feature of this district," he says, "is the mountain chain which extends from St. Abb's Head on the east coast, in a west-south-west direction, to the vicinity of Port Patrick on the opposite side of the island, a distance of 140 miles, with an average breadth of 25 to 30 miles. This high land consists less of a single connected chain than a group of smaller ridges, separated by longitudinal valleys, running parallel to the chief direction of the mass. These ridges and valleys are crossed almost at right angles by another system of valleys, in which many of the secondary streams flow. By these two systems of valleys, the high land is divided into huge oblong mountain masses, often with steep declivities and flat, or almost tabular summits. When seen from the low ground, the mountains have thus apparently a very complex or irregular arrangement; but whenever a proper view is obtained from the high grounds (a map view) their disposal in parallel ridges is distinct. The whole eastern portion of this extended mass of mountains is composed of greywacke and clay-slate. In the south of Scotland these formations cover a space of more than 4000 square miles, or the twentieth part of the whole island, and have thus a considerable geographical importance." A general wedge-like shape, as I take it, composed of a series of smaller wedges, and the whole under escarpments more plane than rounded, consequently presenting angular partitions of faces, and natural lines of whole-figure boundary, which, in map-drawing, is commonly the most defective part of their delineation, and yet should be most strongly marked.

This description of land-forms, by words and other descriptions, such as Mr. Hugh Miller's, in his 'Old Red Sandstone,' seems vastly short of the defined and accurate expression which pictural map-drawing can give, expressively and immediately, to the eye. Nevertheless, Mr. Miller expresses, in words, pictural ideas of land most delightfully. "Physiognomy is no idle or doubtful science in connection with geology. The physiognomy of a country indicates almost invariably its geological character. There is scarce a rock among the more ancient groups that does not affect its peculiar form of hill and valley. Each has its style of landscape"—(and plan-shape and style, too),—"and as the vegetation of a district depends often on the nature of the underlying deposits, not only are the main outlines regulated by the mineralogy of the formations which they define, but also in many cases the manner in which these outlines are filled up. The colouring of the landscape"—(and the plan)—"is well-nigh as intimately connected with the geology as with the drawing." The rest on this subject, in the 11th chapter, is highly remarkable for power and beauty of landscape apprehension; and its transposition into map apprehension is a fine lesson for the map-draughtsman to take and illustrate.

Ruskin, in his work on 'Modern Painters,' says, what the map-draughtsman may take as addressed to him, to direct his study of natural form in *ideal* perception: "The task of the painter in the pursuit of ideal form is to obtain accurate knowledge of the peculiar characters of every species of being, down even to the stone; for there is an ideality of granite, and slate, and marble. A bank of loose earth of any kind that has been at all exposed to the weather, contains in it features capable of giving high gratification to a careful observer. It is almost a facsimile of a mountain slope of soft decomposing rock; it possesses nearly the same varieties of character."

"There is an expression about all hill lines of nature, but it is not to be reduced to line and rule."

"Turner's early drawings are singularly instructive in definiteness and simplicity of aim; they are little more than exquisite studies in light and shade."

This, I think, should surely be the draughtsman's aim in expressing the forms of land in a map.

"All forceful shadow and play of colour surrendered for quiet uniform hues of grey, and chiaro-scuro of extreme simplicity," —"proper for architectural drawings in relievo." This, I think, is exactly what I should say for the shading plans of ground in relievo.

The term *form* is not to be applied to the outline of bodies; "it necessarily implies light and shade; no form whatever can be known to the eye without its chiaro-scuro,—that perfect and harmonious unity of outline with light and shade, by which the parts and projections of the body are explained to the eye."

"The eye of knowledge is as a telescope to the common eye, by which more is apprehended than is immediately seen." Thus forms of land are seen in their origin, composition, &c., to the cultivated eye.

"Truths of specific form are the first and most important of all."

Under such guidance as this, the map-draughtsman may both please the eye with pictural expression in grace and elegance; and the mind, which must be his chief object after all, with the information and description it requires. The subject may not be always beautiful in itself, but in reference to circumstances and associations with what is interesting and important in the knowledge of ground, it may call for *artistic* description in a map, to convey it at least agreeably and satisfactorily to the eye; and what is beautiful in a richly varied face of country may be beautifully pourtrayed.

It may perhaps, be remarked, that this view of topographical plan drawing does not advert to military topography, a question which I might be supposed to entertain as a military surveyor. But my object was to consider the subject of topographical drawing as comprehensively as I could, for all services and demands; and natural history description of ground, in geometrical, physical, and pictural quality drawn, seem to me to compass the proposition. The cause of this kind of drawing being behind other kinds which have the same general object is, that it has been practised chiefly for professional uses, and science has been more regarded as necessary for it than art. Accordingly, the artistic education and direction of the draughtsman has not been adequately provided. He has not been prepared and required to address the mind with that knowledge of nature and art which is due to the subject, and to the observer who seeks information and gratification from the map-picture.

The draughtsman's art is to do justice to nature, and the engraver's to do justice to the draughtsman; on neither should rules and methods be imposed, except by superior artistic judgment, in the employment of each respectively.

## VARNISH BRUSHES.*

CHARLES D. THUM, U.S., *Inventor*.

THE Committee of the Franklin Institute report that the improvements claimed by Mr. Thum, consist:

1. In the form of the handle. This is extended below the ferrule, where it is expanded and bevilled into a wedge. This gives a greater elasticity to the brush, and renders it superior in this respect, to any before known to the Committee.

2. In the oval form of the brush. It has been customary to give a bevilled form to the varnish brush by grinding it upon a stone, or by long use upon coarse work, as house-painting. This, however, destroys, in a great measure, the *flag*, and thus impairs the smoothness and evenness of the edge. Mr. Thum gives the bevilled form by the arrangement of the hair, the flag being

* From the 'Journal of the Franklin Institute.'

unimpaired. This gives a clean edge, and brushes thus made are found very convenient for working in corners and along edges.

3. In the use of *elastic hair*. The mode of selecting and preparing this hair is not disclosed by Mr. Thum. It appears on examination to be finer, darker, more glossy and elastic than the ordinary hair, and is flat or oval rather than cylindrical. While a brush composed of this material is more elastic than one of ordinary hair, keeping in better form, the hairs have never, in the experience of the Committee, been known to break or split.

The Committee believe these improvements to be original with Mr. Thum. On the whole, his brushes are regarded by the Committee as superior to any, whether of foreign or domestic manufacture, which have come under its notice. This opinion is founded not upon mere examination, but embodies the result of actual trial during many months by members of the Committee.

In view of these facts, the Committee fully endorse the opinion of the Committee of Exhibitions, by which a first premium was awarded for the specimens of these brushes deposited in the last Annual Exhibition, and further recommend the award of the Scott Legacy Medal and Premium.

## IMPROVED FORM OF SUSPENSION BRIDGE.*

WILLIAM REED, U.S., *Inventor.*

In this invention, a hollow truss-beam of plate-iron, with cast-iron ends, runs the whole length of the span. In this, the wire is suspended from the upper end of each extremity, and passing towards the lower margin near the centre, the cable and tube being well supported by truss braces, which effect the double purpose of bringing the weight of the truss and all the superstructure of the span on to the cables, and holding the truss-beam in proper shape, acting as the ribs to a vessel. The height of the truss-beam and the thickness of the iron of which it is made, is to be governed by the length of the span. The upper part of the truss-beam must contain sufficient material to resist the compression of the superstructure and load, and the two feet of the lower edge of the truss-beams with the cables, are to support the whole tension. Where the span is long, and breadth of beam is required, in order to save material, the top and two feet of the lower edge of the beam may be made of plate-iron, and the intermediate space filled in with wrought-iron bars, riveted from the top to the bottom, crossing each other, forming a lattice so as to preserve the stiffness of the tube or beam. Where footways are wanted, the floor-beams can be extended out for that purpose. By this arrangement, the whole amount of the tension of the wire can be obtained, while the peculiar form of the truss-beam will cause any weight that may be brought on any part of the bridge to communicate to all parts of the span.

## REVIEWS.

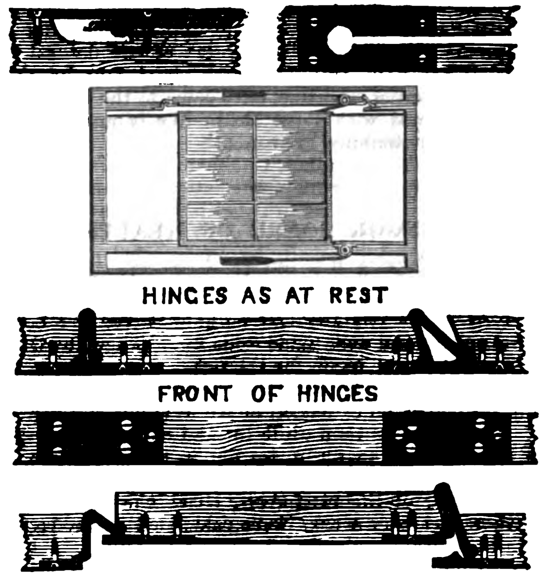
*Manual for Practical Surveyors; containing Methods indispensably Necessary for Actual Field Operations.* By E. W. BEANS, Norristown, U. S. Philadelphia: Moore. 1854.

This little work proposes to assist the practical surveyor, and help him out of his difficulties in the field; but as it is principally devoted to the use of the *circumferenter*, it is not of that value in England as it may be in the United States, for very few surveyors now use that instrument, the theodolite and pocket sextant being considered so far superior to it. However, many useful hints may be gained by the perusal; such as the easiest methods of measuring ponds, rocks, rivers, or inaccessible objects. The following extract may be as well applied to this country:—

"The irregularity of the variation or declination of the magnetic needle in causing uncertainty in retracing old lines of survey, is well known. A step towards obviating the errors attending the old method of finding the difference of variation or declination, and thereby obtaining the present magnetic bearing of the lines of survey, has been taken by the legislature of Pennsylvania, by enacting that meridian lines should be established in the different counties of the commonwealth, and that surveys hereafter made should be returned according to the true, and not the magnetic bearings of the lines."

* From the 'Journal of the Franklin Institute.'

## GRIBBON'S PATENT SASH-MOUNTINGS.




THE object of this invention is to allow the removal of a sash without unfixing the beads. This is accomplished by having half the pulley-stile on one side made loose vertically, and hinged at the top and bottom in the peculiar way shown in the above engraving, the pulley being fixed on the hinged stile and moved with it. When the sash is required to be taken out, it is pressed to the side prepared, when the stile recedes sufficiently to allow the sash to pass the bead on the opposite side. The sash is then drawn out, and the lines, having knots at their ends, are taken out of holders screwed to the edges of the sash, and fitted into others in the pulley-stiles.

## INSTITUTION OF CIVIL ENGINEERS.

THE Council of the Institution of Civil Engineers have awarded the following Premiums for Session 1853-54:—

A Telford Medal, to Nathaniel Beardmore, M. Inst. C.E., for his "Description of the Navigation and Drainage Works, recently executed on the Tidal portion of the River Lee."

A Telford Medal, to Andrew Henderson, Assoc. Inst. C.E., for his paper "On the Speed and other properties of Ocean Steamers, and on the Measurement of Ships for Tonnage."

A Telford Medal, to John Pigott Smith, Assoc. Inst. C.E., for his paper "On Macadamised Roads for the Streets of Towns."

A Telford Medal, to Alfred Charles Hobbs, Assoc. Inst. C.E., for his paper "On the Principles and Construction of Locks."

A Telford Medal, to James Yates, M.A., F.R.S., &c., for his paper "On the Means of attaining to Uniformity in European Measures, Weights, and Coins."

A Council Premium of Books, suitably bound and inscribed, to John Thornhill Harrison, M. Inst. C.E., for his paper "On the Drainage of the District South of the Thames."

A Council Premium of Books, suitably bound and inscribed, to Daniel Kinnear Clark, Assoc. Inst. C.E., for his "Description of the Deep-Sea Fishing Steamer *Enterprise*, with Ruthven's Propeller."

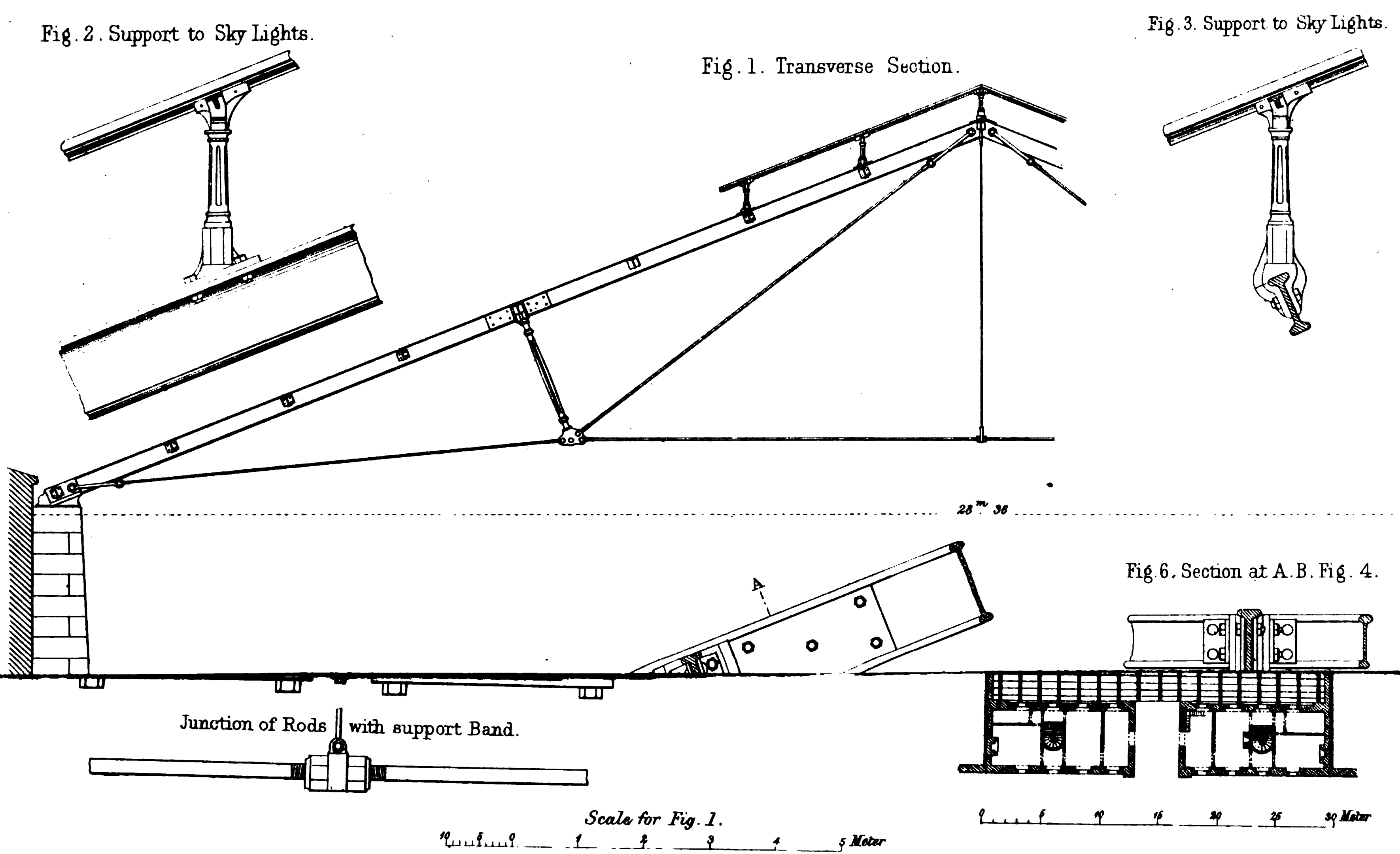
A Council Premium of Books, suitably bound and inscribed, to James Simpson, jun., for his paper "On the Prevention of Smoke in Engine and other Furnaces."

A Council Premium of Books, suitably bound and inscribed, to William Michael Peniston, M. Inst. C.E., for his paper "On the Casualties of Tunnelling, with examples."

A Council Premium of Books, suitably bound and inscribed, to David Chadwick, Assoc. Inst. C.E., for his paper "On Water-Meters."

The Meetings for Session 1854-55 are appointed to take place on the following Tuesday evenings:—In 1854, November 14, 21, 28; December 5, 12, 19 (the Annual General Meeting for the Election of the Council and Officers, and for the Distribution of Premiums). In 1855, January 9, 16, 23, 30; February 6, 13, 20, 27; March 6, 13, 20, 27; April 3, 10, 17, 24; May 1, 8, 15, 22, 29; on the last-mentioned day the President's Conversazione will take place.

# IRON ROOF OVER THE PROVIDENCE MAGAZINE AT PARIS




J R. Jobbins

## PROVIDENCE MAGAZINE, PARIS.

M. Kaulek, *Engineer.*

(*With an Engraving, Plate* XXXIX.)

The roof has been examined with great care by the most competent authorities, and they have come to the conclusion that it has been erected with great skill. We intend giving a full description of the building next month.

## BANGOR BOARD OF HEALTH.

Report *on an Inquiry into certain Allegations against the Proceedings of the Local Board of Health of Bangor.*

TO SIR BENJAMIN HALL, PRESIDENT GENERAL BOARD OF HEALTH.

Sir—Applications were made some months ago, by the Local Board of Health of Bangor, for the General Board's sanction for further mortgage to the extent of 1000*l.*, for the purpose of meeting the cost of an extension of the works of drainage in that town. A request was then made to the Local Board for particulars of this increased expenditure; but in the mean time, certain complaints were made by Dr. O. O. Roberts, purporting to come from a meeting of the ratepayers, as to the injurious effects which these drainage works were calculated to produce in the town.

Examination and inquiry which were then made were sufficient to show that the main statements, as to the levels of the drainage upon which Dr. Roberts's complaint had been founded, were erroneous.

Subsequently, however, Dr. Roberts again addressed the General Board on the subject; and his letter of March 13th contained this statement: "Several cases of fever have recently appeared, and bowel complaints have been indicated in various localities within these districts. Notwithstanding what has been done under the supervision of the Sanitary Board during the past three years and a-half, Bangor is at this moment, with regard to its sanitary prospects, in a worse situation, and in a position more favourable for the reception and propagation of cholera, fever, or any other pestilential epidemic, than ever it has been known to be during the last twenty years."

This statement being calculated to produce considerable alarm, was forwarded to the Local Board. They adopted the judicious course of addressing all the most respectable medical men of the district on the subject, and their replies, which were forwarded to the General Board, certainly bore out the observation of the clerk, that there was "not a word of truth" in Dr. Roberts's statement, and that the district under the control of the Bangor Local Board was generally healthier than it had been for years.

It was thought advisable, however, for the satisfaction of all parties, that a local inspection should be made by an officer of the General Board before sanction was granted for the additional mortgage.

A memorial, dated the 21st ult., having been subsequently addressed to you on the subject from certain inhabitants of Upper Bangor, and an urgent request made, on behalf of the Local Board, that the earliest decision should be come to in respect to the required loan, I had the honour to receive your instructions to attend at Bangor on the 4th instant; and I now beg to submit to you the following report of my examination and inquiries.

Having conferred very fully with the surveyor, Mr. E. Johnson, on the plans and sections, and on the mode in which the works had been carried out, I inspected the district, and examined the main line of sewer at various points.

With the exception of a small portion of the district called Hirael, which lies on the low level, the town of Bangor is very favourably situated for drainage; and I can safely say, that the works have been laid out in a very judicious manner; that they appear to have been extremely well executed, and have been carried out within the original estimate.

With respect to the low district, it is possible that the addition of a very small tank may be found necessary, with self-acting valves, at the junction of the lines of sewer from this part with the main, in order that the action of the drainage may not be impeded at periods of high tide. Some additional work will be necessary, also, for complete surface drainage, and in the removal of old objectionable drains, which will be no longer of use; and when this work shall have been completed, the private works of house drainage carried out, and the whole brought into operation, I believe that there can be no case in which the full advantage of the works will be more likely to be realised.

The complaints which have been raised against them by Dr. Roberts are not founded upon any actual experience of defects, but upon the merest apprehensions of failure, which the ratepayers will be glad to know have not the slightest foundation in fact.

Having made my examination of the works, I attended a meeting of the Local Board, to which the public was admitted, and afforded these explanations. Dr. Roberts, however, then reiterated his objections. His main allegation is founded on the fact, that the actual mouth of the outlet sewer is closed ten hours each day by the tide. Admitting this to be the case, it does not in the least degree affect the drainage of the river, for the junctions of the main, with the exceptions already alluded to, will all be above high-water mark.

Dr. Roberts disputed this, and stated that the sewer would be filled with the tide for three-fourths of its whole length, and that he was prepared with forty witnesses, to prove that the tide had risen nearly up to the bishop's palace.

The bed of the river opposite the bishop's palace is upwards of 20 feet above the highest spring tide level, and if the sea had ever risen to that point, it would actually have reached the roofs of the houses in Hirael, and Dr. Roberts was not prepared with evidence of this. His own statement of the extreme flood level in Hirael is only that of "knee deep."

It is impossible to reconcile this discrepancy, but it would apppear to be probable that the waters alluded to, as having been witnessed at this high level, were those of extraordinary land floods which are said to come down in great violence on rare occasions.

I failed to satisfy Dr. Roberts that this question of floods in no way affected the efficiency of the drainage of the town, but the inhabitants will be glad to know that his conclusions on this point are entirely erroneous.

Dr. Roberts's next complaint was, that the refuse from the gas works should have been allowed to drain into the new sewer. This gas refuse previously drained into the river, and was an intolerable nuisance. It is now no nuisance whatever; but Dr. Roberts contends that at high tide it will be driven into the houses. As no tide will ever reach there, no fear need be entertained on this point. But Dr. Roberts with singular perversity, contends that this drainage of the gasworks into the public sewer is in direct violation of the Water Works Clauses Act, which inflicts a penalty for fouling the streams belonging to waterworks companies, or drains communicating therewith.

Dr. Roberts appeared to have very great complaints to make against the gas and waterworks of the town, and as to the mode in which the waterworks were being executed. These works belong to a company, and as neither the General nor Local Board have any jurisdiction over them, I declined to enter into allegations on subjects with which I had nothing to do. Dr. Roberts could not comprehend this course of conduct, and bitterly complained of it.

A further cause of complaint had reference to the audited accounts. The grievance appeared to be, that these accounts had not been deposited at the right place.

Another of Dr. Roberts's allegations was, that the local surveyor had rendered himself liable to a penalty, for illegally entering into a contract with the Local Board. The facts appear to be these:—Mr. E. Johnson was originally engaged to prepare a survey of the town, and to lay out the plan of drainage, and superintend the execution of the works as engineer, at a per centage on the amount of his estimate. The Local Board, however, subsequently finding that other concurrent professional services were necessary, appointed Mr. Johnson their local surveyor, at a salary of 100*l.* per annum, with the view to his performance of these additional duties; and there can be no doubt that it was perfectly competent to the Local Board to adopt this course.

The memorial from certain inhabitants of Upper Bangor is, for the most part, a repetition of Dr. Roberts's unfounded complaints, but, as it is alleged also, that the Public Health Act had been forcibly extended to that part of the district, and prayed that steps might be taken to put a stop to further progress of works, I felt it my duty to enquire into the circumstances, and to inspect the locality.

So far from any forcible proceedings having been adopted to extend the Act to this part of the district, it appears that no statement whatever was received in opposition to it, on deposit of the report, except from one individual.

On inspection of the locality, I find that it is, for the most part, quite a new district, and although there is no great extent of nuisance there, yet, great complaints are already made of effluvium from bad drains, and it is precisely that kind of place from which the worst consequences must be expected, if neglected much longer. The property has been laid out without any system, the houses being huddled together with small confined back premises, in many of which ventilation is an impossibility.

The chief objection set forth at the meeting to the proposed extension of the works to this spot, was, that the new drains would either pollute the well water, or would deprive the locality of this supply; while the fact is that the sewers will be above this water, and therefore cannot reduce its level, and the very evil which is apprehended by its pollution must very shortly occur unless sewers are constructed for the removal of the refuse.

The Local Board would seriously fail in the performance of their duty, if they did not turn their very early attention to the works required in this part of the district.

I have now remarked on the chief allegations which have been made against the proceedings of the Local Board. Under ordinary circumstances, Dr. Roberts's complaints would scarcely have warranted so much notice, but he has been enabled to excite some dissatisfaction among the poorer class of the inhabitants, and I have been anxious, therefore, to show how entirely they have been deceived.

These works now appear only in the shape of a burden on the town, the rate-payers being necessarily called upon to pay towards their expense before they derive any advantage from them. In a few weeks, however, a better supply of water will be available, when the house drainage may be fully carried out, the surface drainage completed, and all nuisances removed, and the inhabitants will, I feel sure, only congratulate themselves that the Local Board, in the midst of great and undeserved obloquy, have proceeded steadily in discharge of the duties thrown upon them by the Act, and have carried out a system of works which is a credit to the town.

The sum of 1000*l.* to which the Local Board's application for sanction of mortgage was originally limited, is required for the payment of outstanding claims for extension of the drainage works, of which full particulars have been furnished. Some additional works will still be necessary, and the Local Board have therefore now applied for 1200*l.*, instead of 1000*l.*, and I beg to recommend that the General Board's sanction for mortgage be granted for this amount.

*September* 24, 1854. H. AUSTEN.

## LUNATIC ASYLUMS.

The following are the rules issued by the Commissioners in Lunacy to be observed with reference to the selection of the site of an asylum, additional asylum, or accomodation for pauper lunatics.

1. The site of an asylum should be of a perfectly healthy character. A chalky, gravelly, or rocky subsoil is most desirable, but if a clayey subsoil only can be obtained, an elevated position is indispensable, and the foundations must in that case be sufficiently low not to be affected by the variation of the temperature.

2. The asylum should be as central as possible to the mass of the population in the county or district, for which it is to be erected, and should be convenient with respect to its easy access by public conveyances, as well as for the supply of all necessary stores.

3. The site of the building should be moderately elevated, as respects the immediate vicinity, and (if to be drained) undulating in its surface, and cheerful in its position with regard to the surrounding country.

4. It should not be near to any nuisances, such as steam engines, shafts of mines, noisy trades, or offensive manufactories: neither should it be surrounded or overlooked, or be liable to be inconvenienced by the neighbourhood of public roads or footpaths.

5. The airing courts, pleasure grounds, gardens, and fields, annexed to the asylum, should be of such an extent as to afford the patients ample means of exercise and recreation, as well as of healthful employment out of doors; and should be as far as possible in the ratio of at least one acre to ten patients.

6. The site should possess the means of affording a constant supply of a sufficient quantity of good water, and facilities for obtaining a complete system of drainage.

## NOTES OF THE MONTH.

*Architectural Exhibition.*—The Exhibition will be open to the public at the Suffolk-street Galleries on the 11th December next, and will be closed about the 24th February 1855. Two rooms, as before, will be set apart for manufactures, patents, &c., connected with architecture. All drawings, models, &c. must be delivered at the Gallery between the 1st and 5th December. It is suggested that all drawings submitted in the competition of the year should be exhibited.

*Mr. John Dobson, jun., Architect.*—This gentleman, son of Mr. Dobson, architect, of Newcastle, perished in the recent conflagration there. He was a pupil of Mr. Sydney Smirke, and had been a student in the Department of Applied Sciences at University College, London.

*District Surveyor for Deptford.*—An adjourned general quarter sessions for the county of Kent will be held at Maidstone, on the 10th November, when the appointment of district surveyor for the district comprising the parishes of St. Paul, Deptford, and St. Nicholas, Deptford, will be made in the room of Mr. Robert Smirke Martyr, deceased.

*County of Flint Surveyor of Public Works.*—At the last quarter sessions for this county the magistrates appointed Mr. T. M. Penson, of Chester, their surveyor, upon the resignation of their late surveyor.

*Grimsby Cemetery Competition.*—The designs of Messrs. Maugham and Fowler, of Louth, have been selected for the premium of 10*l.* from those of eight competitors. The designs were exhibited for one day in the Town-hall.

*The Elliptical Gun.*—The object of boring the Lancaster gun into an ellipsis is to prevent the ball from taking a rotary motion. It is applicable to small fire-arms as well as large. As tried against the Minie rifle at Woolwich arsenal, the results have thus been officially reported:—With the Minie rifle, at 500 yards, one out of four shots hit the bull's-eye; at 400 yards, one out of three shots hit the bull's-eye; at 200 yards, the whole six struck the target. With Lancaster's smooth-bored patent rifle, same day, at 500 yards, two out of every three hit the bull's-eye; at 400 yards, two out of four hit the bull's-eye; at 200 yards, six shots hit all round the bull's-eye. The practical question now is not that of superiority in force and precision of projection, but in safety. Has the elliptical ball, in passing through the elliptical bore, a tendency to seek a rotary motion? and, being prevented, does it rend the fabric of the gun, or has it a dangerous tendency so to do? If not, what is the cause of those guns bursting so frequently?

*The Sunken Ships at Sebastopol.*—Messrs. W. G. Armstrong and Co., patentees of the hydraulic crane, who have extensive works on the river Tyne, near Newcastle, are busily employed executing an order from the Admiralty for the construction of apparatus for blowing up the sunken Russian ships of war at the entrance of the harbour of Sebastopol. They are twenty-five in number —thirteen large and twelve smaller—and each consist of three concentric water-tight cylinders, placed one within another. The innermost cylinder will be filled with fine gunpowder, and the space between it and the next with ordinary blasting powder, and the outer one left vacant. A galvanic wire inserted in the innermost cylinder will be placed in communication with the battery at the surface. We understand that the order will be completed some time next week, and that prior to their being shipped off to Sebastopol, the effect of one of them will be tried upon a sunken wreck at Tynemouth. The larger ones will weigh three tons each, and when charged four tons.

*Great Guns.*—The large ironworks at Low Moor are fully employed. Last week an order from government was received for 100 guns of immense calibre, we believe Lancaster oval guns, which will throw a ball weighing 94 lb. Besides this, the company have another large order for cannon, which they are executing at the rate of eighteen guns per week.

*Bangor Water and Gas Company.*—An Act for the amalgamation of the Water and Gas Companies, established in this city was passed in July last. The directors report that the line of water-pipes is complete from the proposed service-reservoir at Bangor to the proposed reservoir at the Gaseg (above Bethesda), and that the formation of those reservoirs was being proceeded with as rapidly as possible; pipes had been ordered, and a great portion received, for a 4-inch main into Hirael, and the directors expect to have that main laid and the water turned on in the course of three weeks; and when the service-reservoir was in sufficient forwardness, it was their intention to lay a 4-inch main to Upper Bangor.

*Self-Regulating Gas-Nipple.*—At a recent meeting of the Franklin Institute, U. S., Dr. Rand exhibited Mr. A. Mayer's self-regulating gas-nipple. This is a small cylinder, screwed on the branch, and to which the burner is attached. It contains metallic valves or washers, so arranged that only a certain quantity of gas can pass. It is varied in size according to the capacity of the burner, so as to allow the maximum quantity to pass to attain an economical effect, after which no increase of pressure causes any additional flow of gas.

## NEW PATENTS.

### PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAW AMENDMENT ACT.

*Dated May* 31.

1209. J. Bernard, Club Chambers, Regent-street—Improvements in the manufacture or production of boots, shoes, and other protectors for the feet, and in the materials, machinery, or apparatus employed in such manufacture

*Dated June* 9.

1289. J. Bernard, Club Chambers, Regent-street—Improvements in stitching and sewing-machines, and in machines for securing and ornamenting parts of garments and other materials

*Dated August* 16.

1782. W. C. Forster, Hatton-garden—Manufacture of gas for illumination and heating from materials not hitherto employed for such purpose

1788. W. Burgess, Newgate-street, London—An improvement in or addition to reaping and mowing-machines

*Dated August* 21.

1832. R. Brisco, Low Mill House, Saint Bees, and P. S. Horsman, St. John's Beckermet, Cumberland—Improved machinery for preparing flax, hemp, and other fibrous substances for spinning

*Dated August* 30.

1897. B. Meyers, Savage-gardens, Tower-hill—Improvements in walking-stick guns. (A communication)

*Dated August* 31.

1909. G. Eden, Norwood, Surrey—Improvements in cooking-utensils

*Dated September* 4.

1926. J. Fish, Livesey, and J. Thompson, Witton, near Blackburn—Improvements in the mode or method of picking warps

1928. G. M. Miller, Dublin—Improvements in axle-boxes and parts working in connection with axles of carriages and other vehicles in use upon railways

1930. W. Hill, Congleton, Chester—Improvements in doubling or twisting net or raw silks

1932. W. H. Mitchel, Brooklyn, New York—Improvements in means for distributing type

1934. F. A. Skidmore, and J. Belton, Coventry—Improvements in the manufacture of cast-iron pipes

*Dated September* 5.

1937. W. Brownfoot, Leeds—A new or improved instrument or apparatus for raising, lowering, and adjusting Venetian blinds

1938. F. X. A. Fauvelle, Paris—Improvements in cleaning dressing-combs. (A communication)

1939. H. Trappes, Manchester—A process for the preparation of leather to be used in the manufacture of a new flock, and for the manufacture of the same, to be used and applied in lieu of flock made from pounded or ground wool and woollen materials, heretofore commonly used in the manufacture of painted, printed, and dyed decorating papers, carpets, oil-cloths, and other things, and also to be used as a paste or pulp for the manufacture of all kinds of paper, parchment, and pasteboard, of toys, of ornamental, and other picture-frames, of mouldings, architectural and sculptural ornaments, and other things. (A communication)

1940. S. Stocker, Brighton—Coverings for various parts of the human body, with a view to the preservation of health

1941. W. Barnes, Royal Exchange-buildings—Improvements in fastening rails of railways

1942. J. H. Pape, Paris—Improvements in wind musical instruments

1943. I. P. Trimble, New York—Improvements in regulating the temperature in conservatories and other apartments, or in ventilating the same

1944. J. H. Pape, Paris—Improvements in pianofortes

*Dated September* 6.

1945. J. Eden, Lytham, Lancaster—Improvements in apparatus for drying fabrics

1947. J. Westwood and R. Baillie, Poplar—A method of protecting iron ships and vessels from corrosion and animal and vegetable matters

1948. W. Newbould, Derby—Improvements in the manufacture of busks for stays

*Dated September* 7.

1949. E. Calvert and W. Mitchell, Walton-le-Dale, Lancaster—Improvements in looms for weaving

1950. G. P. Wheeler, Bellevue-place, Mile-end-road, and S. Bremhead, Holford-square, Pentonville—The production of new fibrous materials capable of and suited for the manufacturing of string, rope, matting, and various fabrics, with or without the combination of cotton, wool, or flax, or for pulp for the manufacturing of paper, papier-maché, millboard, &c

1951. P. A. Garnaud, Paris—Improvements in certain gasogene apparatus used for the production of aerated liquids

1952. W. Johnson, Lincoln's-inn-fields—Improvements in coating iron and steel wire with other metal or alloy. (A communication from A. D. E. Boucher and A. Muller)

1953. H. Lund, the Temple—Improvements in propelling and steering vessels, and in the steam-engine applied to these purposes

1954. R. Adams, King William-street—Improvements in breech-loading fire-arms. (A communication)

*Dated September* 8.

1955. J. T. Manifold and C. S. Lowndes, Liverpool—Improvements in windlass fittings

1956. J. Burns, Manchester—Improvements in ventilating ships

1957. J. Youil, Burton-upon-Trent—Improvements in the mode or method of fermenting liquors, and in the machinery or apparatus employed therein

1958. J. Jones, Sheffield—Improvements in metal dinner and desert forks

1962. R. Macallister, Glasgow—An improvement in fitting or applying screw propellers to ships and vessels

1963. W. P. Sharp and W. Weild, Manchester—Improvements in the production of raw and thrown silk, and in machinery and apparatus to be used for the purpose

1964. E. Travis, Oldham—Improvements in apparatus for measuring water and other fluids

1965. J. Atherton, J. Kinlock and J. Swainson, jun., Preston—Improvements in machinery or apparatus for sizeing or dressing yarns or threads

1966. J. Bernard, Club Chambers, Regent-street—Improvements in the manufacture of boots and shoes or other coverings for the feet

1968. B. Hustwayte, Hockley-street, Homerton—An improved construction of metal roofing

1969. H. R. Ramsbottom and W. Brown, Bradford—Improvements in preparing to be spun cotton, wool, hair, tow, and other fibrous materials

*Dated September* 9.

1970. A. Guyarding, Paris—The use of a certain fibrous matter for the manufacture of paper and pasteboard

1971. J. W. Hackworth, Priestgate Engine Works, Darlington—Improvements in steam-engines, and in gearing connected therewith

1972. W. Bowler, Southwark-bridge-road—Improvements in hats and other coverings for the head

1973. T. Hodson, Manchester—Improvements in machinery or apparatus for doubling yarn or thread

1974. T. Clowes, Beverley, York—Improvements in muzzles for horses, or apparatus to prevent horses from biting or sucking their cribs or mangers

*Dated September* 11.

1975. P. R. Jackson, Salford—Improvements in the manufacture of wheels

1976. J. Rigby, Dublin—Improvements in fire-arms and guns, and in waddings to be used therewith

1977. E. Palmer, Southampton—Improvements in propelling vessels

1978. J. Norton, Cork—Improvements in the manufacture of ropes, bands, and cordage

1979. J. Worrall, jun., Salford—Improvements in the method of treating and printing such fustian goods or fabrics as are called "cords" and "thicksets," or "velveteens"

1980. S. Szontagh, Paris—Improvements in sewing-machines

1981. J. C. Purnelle, Tachbrook-street, Pimlico—Improvements in obtaining and applying motive power

*Dated September* 12.

1982. M. Billing, Birmingham—Improvements in manufacturing and ornamenting castors for furniture

1983. E. Gillman, Twickenham—Obtaining filaments from certain vegetable substances and applying the same to various manufacturing purposes

1985. C. W. Forbes, Bartley, Hants—An improved rest for fire-arms

1986. E. Morewood and G. Rogers, Enfield—Improvements in baths or receptacles for melting and containing certain metals for the purpose of coating other metals

1987. J. Williams, Liverpool—Improvements in propellers

*Dated September* 13.

1988. W. Nash and J. Jewell, Islington—Improvements in window-sashes and frames

1989. W. M. Campbell, Glasgow—Improvements in furnaces or fire-places, and in the prevention of smoke

1990. A. E. L. Bellford, Castle-street—Improvements in electro-magnetic clocks. (A communication)

1991. J. Brookes, Birmingham—A new or improved waistcoat

1992. A. H. A. Durant, Tong Castle, Salop—A new or improved axle and axle-box, to be called the anateiros or antifriction axle, which said axle and axle-box may be used for wheel-carriages and for a shaft or axle, and bearings for machinery in general

1993. J. Betteley—Improvement in giving elasticity to ships' standing rigging

1994. H. Crosley, Camberwell-grove, Surrey—Improvements in the manufacture of paper, millboard, and felt from materials not hitherto so used

*Dated September* 14.

1995. J. Hossack, Manchester—Improvements in machinery or apparatus for measuring the flow of water, or other liquids and fluids

1996. C. F. Stansbury, Cornhill—Improved machinery for making screws. (A communication)

1998. C. F. Stansbury, Cornhill—Improvements in punches and dies. (A communication)

1999. A. Wilson and G. Wilson, Nottingham—Improvements in knitting machinery

2000. R. Adams, King William-street—Improvements in machinery for boring and rifling the barrels of fire-arms

2001. W. B. Hayes, Manchester—Improvements in looms for weaving

2002. J. Bernard, Club Chambers, Regent-street—Improvements in the manufacture of boots and shoes or other coverings for the feet

2003. T. Purdon, Hull—Improvements in safety lamps

2004. R. Rawlinson, Westminster—Improvements in valves or adjustable thoroughfares

2005. G. F. Evans, Hanover-lodge, Kew-bridge, and F. J. Evans, Gas-works, Horseferry-road—Improved apparatus to be used in the distillation of coal and other bituminous or resinous substances

*Dated September* 15.

2006. F. Fontenau, Paris—An improved mode of preventing mud from touching or adhering to carriages

2007. J. W. Perkins, Poplar-terrace, Poplar—Improvements in purifying gas, the residuum arising from which forms a new artificial manure

2008. A. Barclay, Kilmarnock—Improvements in refracting and reflecting telescopes

*Dated September* 16.

2009. S. Collins, Birmingham—A new or improved castor for furniture

2010. J. Harrison, J. Oddie, J. Eaves, and H. Graham, Blackburn—Improvements applicable to machines for warping, sizeing, or otherwise preparing yarns or threads for weaving

*Dated September 18.*

2011. W. Simpson, Birmingham—An improvement or improvements in beams or girders for bridges and other structures
2012. J. Ashworth, Bristol—Improvements in sizeing and stiffening textile materials or fabrics
2013. N. Thompson, jun., New York—Improvements in life-preserving seats
2014. G. Thorne and S. Lemon, Fore-street—Improvements in facia-boards, sign-boards, or name-boards
2015. W. E. Newton, Chancery-lane—Improvements in tuning-keys for piano-fortes and other stringed musical instruments. (A communication)
2016. O. D. Smal. Huy—A new system of oven for metals
2017. S. Crabtree, Bradford—Improvements in machinery for combing wool, hair, and other fibrous substances
2018. T. Lewis and A. Bartle, Birmingham—Improvements in apparatus for purifying water

*Dated September 19.*

2019. W. H. Dawes, Handsworth, Stafford—An improvement in the manufacture of iron
2020. G. Piercy and G. Collins, Judd-place West, New-road—Improved apparatus for heating and supplying heated liquids to baths, useful also for supplying heated liquids for other purposes
2021. J. Cunningham, Beith, Ayr—Improvements in the preparation or production of printing surfaces
2022. J. Porter, Salford Screw Boltworks, Manchester—Improvements in machinery for cutting, punching, forging, and forming nuts, bolts, screws, and various other articles in metal
2023. J. Kershaw, Bury, Lancaster—Improvements in looms for weaving

*Dated September 20.*

2025. W. Gee, Birmingham—An improvement or improvements in the manufacture of braces used for boring, driving screws, and other such like purposes
2026. M. Billing and W. G. Whitehead, Birmingham—A new or improved waterproof paper
2027. J. Robinson, Huddersfield—Improvements in apparatus for generating steam and gas, and consuming smoke
2028. W. Garnett, Low Moor, Lancaster—Improvements in and applicable to machines for warping and sizeing yarns or warps
2029. V. A. Pierfet, Paris, and Old Compton-street, Soho—Improvements in watches and clocks
2030. J. H. Johnson, Lincoln's-inn-fields—Improvements in ovens or furnaces for melting or manufacturing glass. (A communication from P. Hutter and Co., Rive de Gier, France)
2031. J. B. E. Savary and J. F. Hazard, Paris—Improvements in pumps
2032. A. E. L. Bellford, Castle-street, London—Certain improvements in machines for drilling stone. (A communication)
2033. A. E. L. Bellford, Castle-street, London—Improvements in machinery for washing paper stock. (A communication)
2034. A. E. L. Bellford, Castle-street, London—A new and improved governor for engines and machinery. (A communication)
2035. A. E. L. Bellford, Castle-street, London—Improvements in sewing-machines. (A communication)
2036. A. E. L. Bellford, Castle-street, London—A new mathematical instrument, to be termed the "horometer," for the purpose of solving problems in plain and spherical trigonometry, one feature of which invention is or may be applicable in the construction of other mathematical instruments. (A communication)

*Dated September 21.*

2037. H. Hudson, Flint Glass Works, South Shields—Improvements in the manufacture of vessels for measuring fluids
2038. W. P. Sharp and W. Weild, Manchester—Improvements in machinery for winding, cleaning, doubling, spinning, and throwing of silk
2039. J. A. Passet, Paris—Improved machinery or apparatus for pressing or calendering fabrics
2040. M. Moneyment, Lamb's Conduit-street, Holborn—Improvements in hat, bonnet, and other boxes
2041. W. Hodson, Kingston-square, Hull—Improvements in apparatus for the manufacture of bricks, tiles, and other articles from plastic materials

*Dated September 22.*

2042. W. Crofts, Derby-terrace, Nottingham-park—Improvements in the manufacture of fringes and other plain and ornamental fabrics
2043. J. E. A. Gwynne, Essex-wharf, Essex-steeet, Strand—Improvements in machinery for lifting, forcing, and exhausting
2044. J. H. Johnson, Lincoln's-inn-fields—Improvements in machinery or apparatus for manufacturing cards employed in the preparation of fibrous materials. (A communication from F. P. Morel, Tarare, France.)
2045. H. Holland, Birmingham—Improvements in the manufacture of umbrellas and parasols
2046. T. Lawrence, Birmingham—Improvements in machinery or apparatus to be employed for the purpose of shaping and finishing certain parts of bayonets
2047. P. Spence, Pendleton, Lancaster—Improvements in obtaining sulphur from iron pyrites and other substances containing sulphur
2048. G. Collier, Halifax, and S. Thornton, Rochdale—Improvements in looms for weaving
2049. W. J. Brown, Bristol—Improvements in a composition or combination of materials to be used for sizeing yarns and other articles

*Dated September 23.*

2050. T. Garnett, Liverpool—Improvements in steam-engine and other governors
2051. P. Feloj, Fleet-street—Improvements in the manufacture or construction of a knife and fork
2052. T. Banks, Derby, and H. Banks, Wednesbury—Improvements in apparatus for retarding and stopping railway trains
2053. S. E. Hoskins, Guernsey—An improvement in the manufacture of paper
2054. J. H. Johnson, Lincoln's-inn-fields—Improvements in the generation of steam. (A communication from P. J. C. Montety, France)
2055. R. Pinkney, Long-acre,—Improvements in stoppers, corks, or valvular apparatus bottles or receptacles for liquids, and in the machinery or apparatus employed for making the same
2056. G. M'Naught, Glasgow—Improvements in saddle-trees
2057. G. Danré, Marseilles—Improvements in gas-burner
2058. H. A. Genetreau, Paris—An improved system of carriage-shafts, poles or beams

*Dated September 25.*

2059. W. Marshall, Wachinghem, Pas de Calais—An improvement or improvements in metallic wheels for railway and other purposes
2060. R. M'Connel, Glasgow—Improvements in locks
2061. P. J. Chabot, Spitalfields—Improvements in supplying air to furnaces
2062. H. H. Bigg, Leicester-square—Improved apparatus for curing deformities of the human frame
2063. H. C. C. de Ruols and A. L. M. de Fontenay, Paris—Improvements in the treat- of certain metals for producing an improved metallic alloy
2064. W. P. Surgey, Hackney—Improvements in cigars, cigarettes, and cheroots

*Dated September 26.*

2065. J. B. Halsey, Norfolk-street, Strand—An improved machine or apparatus for crushing and pulverising ores, and for separating the gold therefrom by amalgamation
2066. L. Cornides, Trafalgar-square—A new mode of manufacturing a transparent medium, plain, printed, and coloured, of gelatine, in combination with other substances
2067. J. Boulton, Coppice-row, Clerkenwell—Improvements in dry gas-meters
2068. G. Spencer, Alpha-road, New-cross, Deptford—Improvements in the external coverings of roofs and walls of buildings and sheds, and in the windows of such buildings and sheds
2069. W. F. Sadler, Tooley-street, Southwark—A machine or apparatus for using up all the smoke of furnaces and other fire-places
2070. T. Clayton, Oldham, and R. Harrop, Lowside, near Oldham—Improvements in ornamenting wood, and in the machinery or apparatus connected therewith
2071. The Honourable J. Sinclair, commonly called Lord Berriedale, Hill-street—Improvements in treating, cleansing, and ornamenting paper and other surfaces

*Dated September 27.*

2073. J. S. Holland, Woolwich—Improvements in large and small firearms, and in the preparation of their charges
2074. W. K. M'Minn, Robert-street North, Liverpool—Letting go and heaving up ships' anchors, which he calls a double acting anchor purchase
2075. C. Barraclough, Halifax—Improvements in machinery or apparatus for the manufacture of clog soles and patten soles by power
2076. J. Edge, Bolton-le-Moors—Improvements in pistons
2077. J. Chambers, Manchester—Improvements in washing fabrics, and in machinery employed therein
2078. R. Hoyle, Whitehead-bridge, Bury, Lancashire—Improvements in preventing incrustation in steam-boilers
2079. R. Renfrew, Glasgow—Improvements in bobbins

*Dated September 28.*

2080. F. Clark, King-street, Westminster—An improved spindle and bush for door-knobs, and other similar uses
2081. A. Y. Crosse, Blackheath—Improvements in the manufacture of buttons
2082. J. Rogerson and J. Brimelow, Bolton—Improvements in certain parts of steam-engines
2083. J. Simpson, Rochdale—An improvement in the manufacture of printers' blankets
2084. A. V. Newton, Chancery-lane—Improvement in the rigging of sailing vessels. (A communication)
2085. W. Hutchinson and W. Barlow, Salford—Improvements in steam boilers
2086. W. B. Johnson, Manchester—Improvements in lamps and other apparatus used for illumination
2087. G. Crux, Manchester—Improvements in the production of bonnets, children's hats, and similar coverings for the head
2088. J. Woodward, Barnet, Hertford—Apparatus for stopping shot and other holes in ships and vessels
2089. C. W. Lancaster, New Bond-street—Improvements in fire-arms, and in cartridges to be used therewith
2090. M. Poole, Avenue-road, Regent's-park—Improvements in cylinder paper machines. (A communication)
2091. L. Beer, Elbeuf (Seine Inférieure,) France—Improvements in machinery for shearing piled, terry, or raised fabrics

*Dated September 29.*

2092. T. F. Griffiths, Birmingham—Improvement or improvements in lamps
2093. T. Mohan, Aclint, Louth—Improved churn
2094. W. Sneath, Derby-road, Nottingham—Improvement in sewing-machines
2095. J. N. Gamewell, Camden Kershaw district, South Carolina—Improvements in instruments for relieving the wires of the electric telegraph of atmospheric electricity
2096. J. H. Johnson, Lincoln's-inn-fields—Improvements in machinery for removing the points from the hairs of rabbit and other skins employed in the manfacture of hats, and similar articles. (A communication from P. D. Chaumont)

*Dated September 30.*

2098. J. Bradbury and J. Bradbury, Denton, Lancaster—Improvements in machinery or apparatus for manufacturing or producing piled goods or fabrics
2100. G. Filhon, Paris—Improvements in glass chimneys for gas-burners or lamps
2102. A. Boyle, Birmingham—Improvements in making umbrella and parasol stretchers
2104. G. F. Wilson and G. Payne, Belmont, Vauxhall—Improvements in the manufacture and application of rosin oil

*Dated October 2.*

2106. T. Gray, St. Clement's-lane, Strand—A new and improved method of preparing and bleaching raw and fabricated fibrous substances now used in the manufacture of paper, or which are applicable to be used in such manufacture
2108. W. W. Cook, Rumforth, near Bolton—Improved method of weaving or manufacturing woven fabrics suitable for petticoating, or similar purposes, where thick and thin parts of the same fabric are required
2110. W. Partington, Bonhill, Dumbarton—Improvements in bleaching
2112. C. B. Hare, Bristol—Improved mode of manufacturing printing blocks
2114. J. Penn, Greenwich—Improvement in the bearings and bushes for the shafts of screw and submerged propellers
2116. J. Stephens, the Temple—Improvements in apparatus for supplying purified air to rooms or buildings

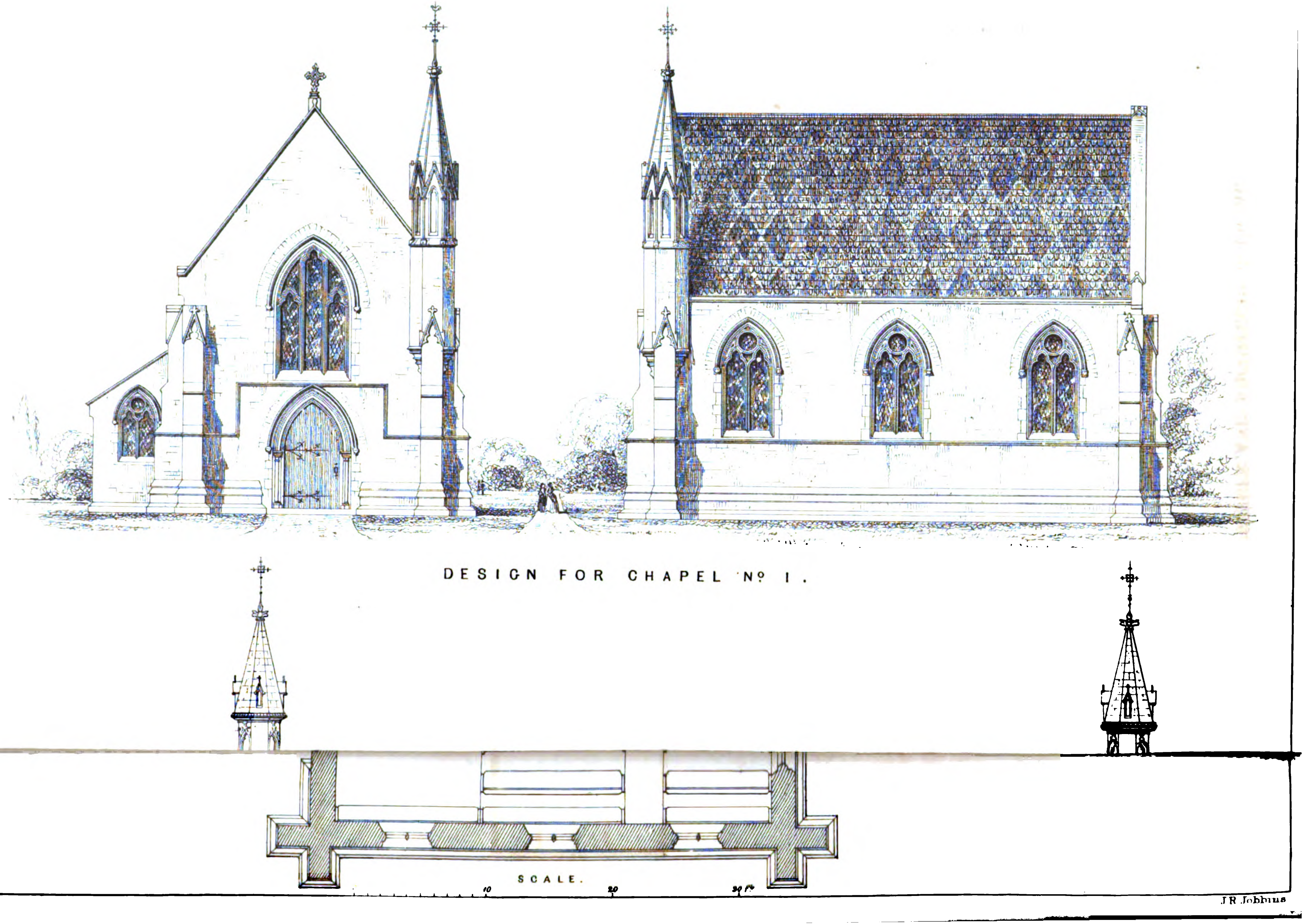
*Dated October 3.*

2120. J. Jeyes, Northampton—Improvement in the manufacture of paper, threads and yarns
2122. W. E. Newton, Chancery-lane—Improvements in the construction of locks. (A communication from L. M. Eiler, Copenhagen)
2124. C. Nickels, Albany-road, Surrey, and J. Hobson, Leicester—Improvements in apparatus used when weaving piled fabrics by the aid of wires
2126. T. Cooper, Isle of Wight—Improvement in the manufacture and in the mode of joining earthen pipes

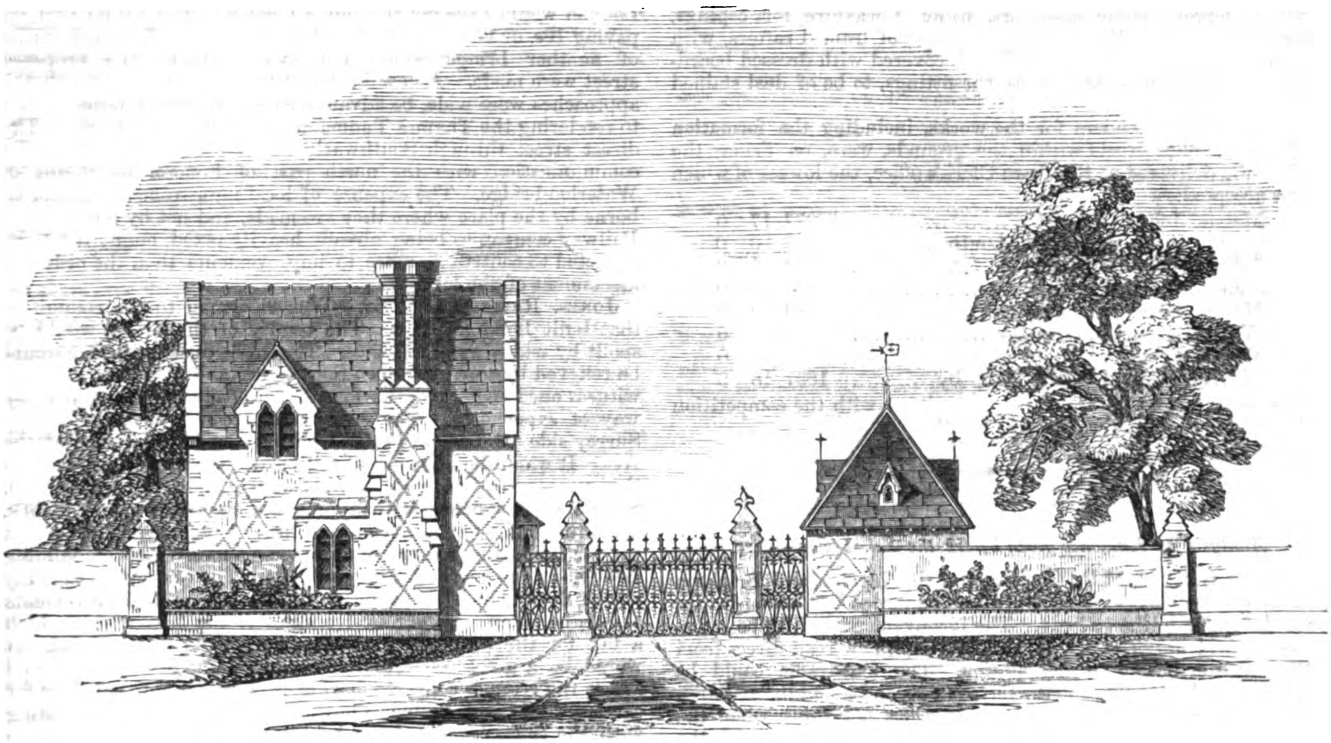
## PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

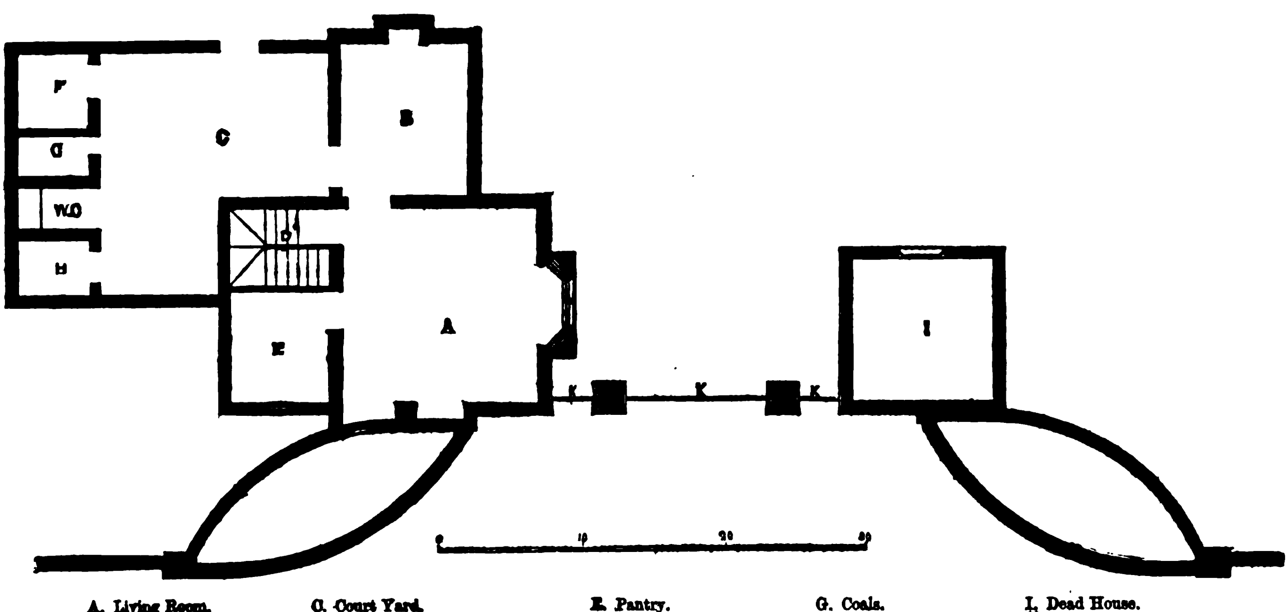
2173. P. E. Proust, Orleans, department of Loiret, France—A new system of apparatus for greasing or lubricating axles and other rotating portions of carriages and of machinery—October 11
2174. J. F. J. A. Boullet, La Chapelle St. Denis, near Paris—Improvements in the manufacture of steel—October 11
2196. A. B. Baron Von Rathen, Wells-street—Improvements in bakers' and confectioners' ovens, and in furnaces or fireplaces connected therewith, parts of which improvements are applicable also to other ovens, furnaces, and stoves—October 14
2223. R. J. Chippindall, Rue de la Rochefocauld, Paris—An improved pencil-case—October 17

# CHAPELS FOR GRIMSBY CEMETERY.




DESIGN FOR CHAPEL Nº I.






A. Living Room. B. Kitchen. C. Court Yard. D. Staircase with Closet. E. Pantry. F. Tool House. G. Coals. H. Ashes. I. Dead House. K, K. Iron Gates.

## GREAT GRIMSBY CEMETERY.

(*With an Engraving, Plate* XL.)

In reply to the advertisement of the Town Council of Great Grimsby, offering to architects a premium of 10*l.* for the design of which the Council should approve, for the intended new cemetery at that place, a great number of drawings were submitted by ten competitors for their consideration. The designs were sent in under motto, and having been exhibited for a short time in the Town-hall, the one by Messrs. Maugham and Fowler, architects, of Louth, marked "Necropolis," was unanimously adopted, and the authors (as stipulated in their sealed communication) appointed by the Corporation to superintend the works.

The ground selected for the site, about eight acres in extent, formed a portion of the Corporation estates, and is conveniently situated on the south side of the town, adjoining the East Lincolnshire Railway; it is quite flat, of a strong clay subsoil, with the exception of a small mound of sand in the south-east corner. The whole is to be inclosed with a dwarf-wall and iron pallisade boundary fencing, eight feet high, in conformity with the Grimsby Improvement Act.

The design comprises two chapels, with sexton's lodge and dead house. The Episcopal chapel, which has received the approval of the Bishop of the diocese, is Curvilinear in design, of the best period of that style, with four-light windows of double-planed flowing tracery at each end, and two-light windows on the sides. The bell-turret forms the apex of one of the gables. The Nonconformist chapel is of Geometrical character, with bell-turret on one angle of the building above the buttresses. The entrance-lodge, &c., which is of simple character, is in corresponding style. The whole of the buildings are to be executed in red stock bricks (the neighbourhood not affording suitable walling-stone), with Ancaster stone dressings, using Yorkshire for copings, weatherings, &c. The roofs to be formed of framed rafters, with arched ribs in the Episcopal chapel, covered with dressed boarding, and the whole, as well as the fittings, to be of deal stained and varnished.

The following tenders for the works, including the formation of the intended roads within the grounds, were, on Friday the 17th ult., delivered at the Town Clerk's office, the lowest of which was accepted:—

| | | | |
|---|---|---|---|
| Messrs. Johnson, Laceby | £2377 | 17 | 0 |
| George Emerson and Co., Louth | 2287 | 0 | 0 |
| John Dales, Louth | 2274 | 0 | 0 |
| James Miller, Tetney | 2200 | 0 | 0 |
| Messrs. Brown, Grimsby | 2089 | 0 | 0 |
| William Johnson, Grimsby | 1953 | 0 | 0 |
| Messrs. Friue and Thompson, Brigg | 1945 | 0 | 0 |
| William Hollingsworth, Grimsby | 1897 | 18 | 0 |

The estimate of the architects, submitted with the competition design, for the same works, was 1885*l.*

## METROPOLITAN BRIDGES.

***Analysis of Evidence given before the Select Committee.****

Laing, Samuel, M.P., Chairman of the London and Brighton Railway Company—Insufficient space is afforded by London-bridge for the traffic to the railway. The inconvenience might be remedied by widening the bridge, and making a new road direct from Westminster-bridge to the station. The foot-traffic could be relieved by better piers on the Surrey side, and an additional arch to supersede crossing on the bridge. Does not think when the West-end Railway is opened, which is to communicate with the Crystal Palace, it will give great relief to the traffic to and from the London-bridge terminus, because the whole of the East-end of London, the most crowded and populous part of the metropolis, will still naturally go to the London-bridge station as the nearest; whatever traffic to the Crystal Palace we get at the London-bridge station will be in addition to the present traffic, the amount of which is quite enormous. The total number of passengers travelling on the Brighton Railway, which in 1848 was only 2,485,778, had increased in 1853 to 4,491,561; that is irrespective of the vast numbers travelling by annual or periodical tickets. Taking the different lines of railway, the lines of the South-Eastern Company, and the lines of the Brighton Company, the total number of passengers crossing London-bridge annually, to and from, may be taken at nine millions and a half; that would give an average of upwards of 25,000 a day for the whole year; but of course that number is by no means uniformly distributed; and on particular occasions, and during the summer season, you have twice that number very often. And in addition to that, the trains go at certain hours, so that the stream of passengers is not regular, but is much larger at certain hours than it is at others. It would not improve matters to make Southwark and Waterloo bridges free, as long as the route was so intricate through Southwark. The bridge funds should be made available for improving the bridge. His impression is that London must be considered as one great whole, and that there ought to be some large central body, however elected, who should control and superintend all great improvements, whether roads or bridges, or sewage or drainage, or other great public purposes; and that the funds for those purposes should be levied by rates within the metropolis, and not imposed upon the country; and that probably the adjustment of the rates for particular districts might be made according to some sort of approximate estimate of the extent to which particular districts might be benefited in comparison with the whole. Considers that if the coal duty is carried to the extent of an area of twenty miles, it is an unjust and harsh tax upon the inhabitants of the country; but if it is confined within the fair area of the metropolis, is not then so sure, if the money must be raised, that it is a worse mode of raising it than by a system of direct taxation; but it should be confined to the district benefited. There would be no injustice in making the bridge funds bear the expense of the suggested improvements. Assuming it to be the fact, as shown by the reports of the various railway companies, that 650,000 tons of coals were brought into London by the different railways for the consumption of the metropolis, thinks the consumers of coal in London would have got through a portion of last winter without paying 10*s.* or 20*s.* a ton higher than they did. The construction of another bridge would not avail without the proposed street were made. A new bridge at Charing-cross might, if the approaches were wide, be advantageous. There are impediments to rendering the Thames Tunnel more available for traffic. The direct street through Southwark would probably facilitate the communication with the north part of London by means of Waterloo-bridge. The expense of local improvements should be borne by the place where they are made, and not by the country. Railway companies being already heavily taxed, ought not to be expected to contribute more to improvements than the ordinary assessment of the locality.

Jones, Richard Lambert—Was chairman to the committee that built London-bridge. The beauty of the bridge would be spoilt by widening the surface. The traffic over the bridge would be relieved by throwing open Southwark and Waterloo bridges; witness once suggested the former being opened for a year by way of experiment. The erection of steam-boat piers on the Surrey side of London-bridge would be an infringement of the Act. It would be useless to throw open Southwark-bridge unless the communication with the railway station were improved. Suggests a new bridge with approaches starting from St. Paul's. The inhabitants of the city are not likely to approve of any direct tax for facilitating the traffic over the bridges. Cost of building London-bridge was about two millions. The coal-tax is the only source from which the expense of the proposed improvements should be taken. Ten or twelve miles is the area within which a tax for the proposed improvements ought to be levied. It would be a great relief to the traffic coming from the Strand across the river to convert Charing-cross-bridge into a bridge for carriages. It is desirable to have a direct street communicating with the Surrey ends of the bridges. Has a great objection to any tax for building a new bridge. The throwing open Vauxhall-bridge would not be any advantage in relieving the city traffic.

Tyrrell, Edward—The inhabitants of the metropolis are strongly opposed to the imposition of any tax upon them alone for purchasing or throwing open the bridges. It would be considered as a contrivance for relieving those who had entered into a bad speculation. There would be a stronger indisposition to buying up bridges than for building a new one, although the latter would be viewed in an objectionable light. Does not concur in Mr. Laing's suggestions. The coal-tax, or any tax raised within the twenty mile area, would be the fairest manner of freeing the bridges.

Brand, Ferdinand, Comptroller of the Bridge-house Estates—The Bridge-house Estates consist of land, houses, wharves, warehouses, and other buildings which are held by the mayor, and commonalty, and citizens of the City of London, in trust for the maintenance and support of London-bridge. They were derived originally from gifts and grants from the Crown, and gifts from different individuals, and purchases made out of the surplus income arising from those estates, and other portions have been purchased with the produce of property sold at different periods under the authority of various Acts of Parliament for effecting public improvements and other purposes. There is a portion of the property situated at Stratford, in Essex, which is also liable to the support of two bridges there, called St. Michael's-bridge and Peg's-hole-bridge, and a portion of the roads adjoining. The specific trust is confined to the maintenance and support of London-bridge. The Corporation have the option of either widening the present bridge or building a new one. The existing incumbrances on the Bridge-house Estates will prevent any further expenditure in repairing Blackfriars-bridge. Reports were made on the state of Blackfriars-bridge by Messrs. Walker and Burges, and by Sir William Cubitt and Mr. Brunel, and on the reference of them to the Court of Common Council they concurred in the necessity for rebuilding the bridge. The Bridge-house Committee are at present considering a plan for widening London-bridge. Negociations have been opened by the committee with the directors of Southwark-bridge for the purchase of the bridge. The directors ask 300,000*l.* for the purchase. It was intimated to the Bridge-house Committee, that unless that sum was immediately given, in all probability a larger sum would be asked. There seemed to be an impression amongst the directors that the bridge must be purchased for the benefit of the public, and that they would therefore have a chance of getting their own price. Witness finds from the reports of the company that the

* For Report of Committee, see *Journal*, ante p. 350.

average annual amount of the net dividends of the Southwark-bridge Company, for the fourteen years ending 1848, is about 2,270*l*. He has no means of going lower than 1848. Now, supposing that be taken at thirty years' purchase, it would be 68,000*l*.; taking it at forty years' purchase, it would be 91,000*l*. The preference shareholders are the only persons who receive any income whatever. The preference shareholders have a right to 7½ per cent, and until the 7½ per cent. is paid to the preference shareholders, the other shareholders do not get anything. The tolls of the Southwark-bridge appear to fluctuate a good deal. They are rather decreasing than increasing; but thinks probably they may now increase, as the City has been opening New Cannon-street. There are impediments to throwing open the bridge for a year as an experiment. The Bridge-house Committee do not propose to pay for Southwark-bridge in the event of a reasonable offer from the directors, but to press the necessity of the purchase being made by the government. Witness proposes an improvement to the steam-boat landing at London-bridge. The arch suggested by Mr. Laing at the Surrey end of the bridge is already there. The Common Council are willing to contribute liberally to the purchase of Southwark-bridge. It would not be advisable to defray any improvements by a rate, on account of its unpopularity.

BUNNING, JAMES, Architect to the Corporation of London—Prepared the model now before the committee for the widening of London-bridge. Had it in his mind for some years, but owing to the immense mass of business he has had to attend to for the corporation, has postponed it till it appeared to him that the traffic had increased to such an extent that he thought no more time should be lost. The design was made with the intention of projecting parapets over the sides of the bridge, and constructing the footways by means of iron cantilevers, bolted down to the voussoirs of the bridge. Of course the traffic for foot-passengers does not require so stable a construction as that for the carriage-way; and by this system the entire solid part of the bridge would be thrown up for the carriage traffic. The parapet is intended to be of wrought-iron, and the cantilevers of cast-iron, and will be painted to agree with the stonework of the bridge, so that as little as possible of the architecture of the bridge should be destroyed. Feeling a good deal of delicacy in altering Sir John Rennie's work, witness suggested to the Bridge-house Committee that he should be consulted. They kindly agreed to that; and not only did they think it necessary that Sir John should be consulted about the architectural effect, but that he should also be satisfied that it was not intended to put a greater weight upon the bridge than it could bear, for there has been a settlement in the bridge. They not only sanctioned Sir John Rennie being employed, but they coupled with him Mr. Page. Those two gentlemen witness had the pleasure of meeting. Soundings are now being taken, and there is no doubt that the report will be made shortly. The extent of the addition proposed to be given is a pathway of 9 ft. 6 in. or 10 feet on each side. The centre line or division upon the model along the middle of the bridge was an idea for facilitating the traffic. If the vehicles passing north and those going south were divided into two separate lines, it would increase the facility greatly. The estimate was 30,000*l*.; but the rise of material has been exceedingly great since then; he should think 20 per cent., and that it would cost now 36,000*l*., including the new road. Independently of the footpaths, the roadway will be very nearly 50 feet; it is now 30 feet. This addition would be carried out in iron. The scheme, he admits, would not improve the bridge. But the question is, whether, circumstanced as London-bridge is, utility is to give place to architectural effect, or appearance and beauty is to give place to utility. He should certainly prefer the bridge remaining as it is in an architectural point of view; in fact, that was one point upon which he was exceedingly desirous that Sir John Rennie should be consulted, that if he had any objection to make to the committee he should be at liberty to do so, because it appears very wrong to interfere with gentlemen's works without consulting them. It would rather lessen the pressure than otherwise, because there are some very heavy granite parapets which would be removed. At the present moment, Sir John Rennie and Mr. Page are confining themselves to the soundings of the river. Sir John Rennie certainly does not appear to like the scheme at all. Cannot say what his report will be to the committee. There is no difficulty in making a passage through the end of the bridge on the south side, so that persons coming by the steam-boats might be able to pass from one side of the bridge to the other without crossing the main line of traffic. The widening of the bridge would not render it unnecessary; the design is quite a distinct thing altogether, to enable a person instead of crossing over the bridge to pass through it. The plan originated with Mr. Dawson.

BENNOCH, FRANCIS—Is the projector of the plan for a bridge across the Thames from St. Paul's. Sometime since calculated the expense of the actual bridge, and the approaches to that bridge from the level on the City side to the level again on the Surrey side. The estimate at that time was 120,000*l*. for the construction of the bridge, and 24,000*l*. more for the approaches on both sides of the bridge from level to level, making a total of 144,000*l*. Since that time, materials as well as labour have risen considerably, and if an estimate were to be given now it would be probably 20 to 25 per cent. higher than it was then. The width of the proposed bridge was 60 feet; but is now of opinion that instead of being 60 feet, it would be a wise economy to have it 80 or 90 feet wide—almost to have two bridges in one—because the traffic at this point would immediately be immense. It was proposed that the piers should be stone, with wrought-iron girders. Considers that a bridge could be built at that part of the river cheaper than anywhere else, because the property from St. Paul's-churchyard to the river side is property of comparatively little value; the streets are narrow, contracted, and ill-adapted to great commercial operations; so that warehousemen who require a considerable amount of room for their wagons avoid them. When you come to Thames-street, the property is necessarily very valuable, because of the number of wharves in that immediate neighbourhood; but it singularly enough happens, that just at that particular point the property is of less consideration than any other property which could be touched upon between the Temple and the Tower; this happens to be an iron wharf, where plain sheds are required to protect it from moisture and corrosion, and this could be done much better by the dry arches of a bridge on girders carried upon columns, and would form altogether a much better wharf than the owners now have. Then, on the Surrey side, thinks it would be almost impossible for the imagination to conceive a condition of society more fearful than that of the population through which the approach would go on that side from the point at which it touches the bank until it reaches the junction of the Southwark-bridge-road, near the Elephant and Castle; it is impossible for language to describe the condition in which the people are there, not living, but festering. It would be a great improvement to clear that neighbourhood away for the purpose of making an approach to the bridge; also as advantageous in a sanitary point of view as the construction of the bridge would be to the traffic. This line happens to come between two great thoroughfares, Blackman-street on the one side, and Blackfriars-bridge-road on the other side, and there is no other main street running through the district excepting the crooked approach to Southwark-bridge. The people have got crowded together, and the alterations made in other parts have driven the poor into this particular locality in great numbers. Thinks it would be an excellent plan to take advantage of such an opening to construct a large series of dwellings for the poor in that particular locality, where they are needed, near the river side, and sufficiently near their work to enable them to go to and fro without much fatigue or loss of time. Has had many designs and suggestions from people desirous of bringing their plans before the public. His attention has been directed to one of the most gigantic kind, which for elaboration, beauty, and adaptability, not only to the present necessities, but to all that may hereafter be required, surpasses every structure hitherto conceived; and witness has been told it can be executed for much less than the corporation believe would be required for an ordinary bridge. The scheme is this: the government have some notion of bringing the railways into connection with the Post-office, and if that be considered necessary for postal communication with the north of England, it is of course infinitely more required with regard to the continental postal arrangements, and that could be effected more easily from the southern than from the northern side. A railway is projected to come to the southern side of the river, and by a bridge at this particular point, with arrangements for a railway underneath, through which the mail-trains might pass, and enter a tunnel as soon as it reached the City side of the river, and come up to the Post-office, where the bags could, without labour or loss of time, be deposited. That has been provided for in connection with this bridge referred to. The name of the designer is Mr. Sang. Witness's bridge would not interfere with New Cannon-street; that street would form necessarily one of its approaches. New Cannon-street comes into St. Paul's-churchyard at the south-east corner of the cathedral; the street should spring from Watling-street if the new bridge is to be constructed; and one must be constructed in the course of time, since more bridges are really required, and that is perhaps of all positions about the best that could be chosen for the erection of the first new bridge. Starting from Watling-street and crossing New Cannon-street, it is about fifty or sixty yards to Old Fish-street, and that would be the point from which the new bridge would take its rise upon the dry arches, and be continued at a dead level till it reached the Surrey side of the river. There is a new street projected here to go to Earl-street, Blackfriars, in order to give relief to Ludgate-hill. The only object of this new street from this point at Bow-lane to Earl-street is to relieve Ludgate-hill of the traffic of this quarter that desires to cross the river. Here there is a large amount of expenditure proposed, merely for the purpose of accommodating the traffic from this point to Blackfriars-bridge. His opinion is, that Blackfriars-bridge is not sufficient, but that a new bridge must be made somewhere, and without loss of time. These new approaches to Blackfriars by Earl-street would cost at least from 180,000*l.* to 200,000*l.* Has no hesitation in saying that more than half the new bridge and its approaches could be constructed for the cost of this one new street; then not only a new line for traffic is got over the water, but the taking of the expensive property which the Earl-street extension would cross diagonally, is avoided. Is aware that this new street is proposed to be constructed for the purpose of taking off the traffic which comes over Blackfriars-bridge; but it so happens that Blackfriars-bridge is probably the worst position for a bridge that there is in the metropolis. They have chosen the lowest part on each side of the river as the place from which the bridge should spring. Now seven-eighths of all the traffic over Blackfriars-bridge comes from a high level, so that both on the Temple-bar side and on the St. Paul's side of the valley of the Fleet they are obliged to descend a hill to get down to the point from which the bridge springs. Then they must ascend a hill to get over the water, and Blackfriars-bridge hill is nearly as bad as Holborn-hill. Any wagon coming from any part of Southwark south of Blackfriars-road would never come over Blackfriars-bridge, but over the new bridge, and would save the double hill. Produced a table showing how the traffic arranges itself. Has gone into the question with reference to this improvement, and the statement shows the traffic of vehicles passing from Ludgate-hill over Blackfriars-bridge, and *vice versâ*, and from Earl-street over Blackfriars-bridge, and *vice versâ*, from 9 a. m, to 6 p. m., on Wednesday, February 8th, 1854. The Ludgate-hill portion of the traffic going over Blackfriars to and from the Old Bailey is as follows:—Islington and Kennington omnibuses 128; all other vehicles, 985; making a total of 1113. The vehicles that go over Blackfriars-bridge to and from St Paul's Churchyard are, 29 South-Western Railway and City omnibuses, and 405 of other vehicles; making 434. The vehicles going along Earl-street are, cabs, 83; all other vehicles, 502. Presuming that those 83 cabs have probably come from St. Paul's Churchyard down to Earl-street to avoid Ludgate-hill, I have therefore added them to the 434 vehicles to and from St. Paul's Churchyard; making a total of 517. Thus we have 517 vehicles going down Ludgate-hill to pass over Blackfriars-bridge, while we have 1113 going along the Old Bailey, and so over the bridge. The other vehicles, to the number of 502, consist of wagons, &c., which do not come from or go to the upper level towards Cheapside, except in rare instances, and therefore cannot enter into any calculation with reference to the new street. So this new street, if constructed, would only accommodate 517 vehicles during the day; and if you suppose that they would go at the rate of three miles an hour, it would leave each vehicle in this distance eighty-eight yards apart, instead of crowding upon each other as they do at present on Ludgate-hill. An omnibus starting from the Post-office to go to Kennington would be at the Elephant and Castle before it at present gets to Blackfriars-bridge, in consequence of the perpetual crowd and crush at various corners. Blackfriars-bridge will never be good for much until rebuilt. When brought down to 20 feet headway it may become a good bridge. There is a scheme afloat to adapt the river to the bridges by artificial dams, instead of adapting the bridges to the river. How this is to be done may perhaps be gathered from witnesses versed in City affairs. Now, in considering the best way to relieve the traffic in the street, of course the first question is in reference to the bridges. In fact, it was noticing the crowding of the bridges that led witness to devote his time to considering the question how we should best relieve the traffic of the streets. Finds that the traffic in the streets increases very rapidly, perhaps in a proportion that we can hardly believe; but taking the calculation for four years, finds that the traffic over London-bridge increases year by year from 5 to 7½ per cent. Has taken it for four years. Considers that it has increased in four years 30 per cent. at least. If Southwark-bridge be taken as about the centre of the City at the present moment, half-way between London-bridge and Blackfriars, and if a line be drawn from north to south, finds that there is all that enormous population lying south and east of the Elephant and Castle and the Clapham-road, which must come over London-bridge. And all that enormous population lying north-east of the Thames, east of Goswell-road, and the Angel, Islington, embracing the district of Finsbury, the Tower Hamlets as far as Limehouse and Stepney, and the whole of Hackney, Hoxton, Clapton, and Tottenham; and the wagons along the Docks have no other means of getting across to Rotherhithe or the railways on the other side than by London-bridge. Take, for instance, Mr. Torr, the animal charcoal-burner in Rotherhithe. He supplies the sugar-refiners on the Middlesex side with charcoal with which to refine their sugar; he employs some forty or fifty horses; witness believes he has ten wagons constantly employed; they are obliged to traverse three miles on the Surrey side, and three-and-a-half or four miles on the Middlesex side, to carry materials from one place to another, which are not a mile apart if they had a direct communication across the river. Taking the population on both sides, London-bridge supplies a population of at least a million; that is to say, a million of people requiring bridge accommodation have only London-bridge to give them that accommodation. Finds that in 1801, when the population was only 958,000, there were three bridges. In 1811 the population was 1,138,000, but we had no addition to the number of bridges. In 1821 the population was 1,378,000, and we had two additional bridges completed, which were found to be essential, making five in all. In 1831 we had one bridge widened; still we had only five bridges, although the population had risen to 1,654,000; the bridge widened being New London-bridge, which was opened in that year. In 1851 there was another bridge added, the Hungerford foot-bridge; making six bridges in all. But at the last census the population was 2,361,640, and yet we have no more bridge accommodation than we had when the population was 800,000 less. However rapidly the population has increased since the last bridge was opened, it has been trifling when compared with the increase of wagons, carts, carriages, cabs, and omnibuses, the latter being unknown before 1828, demanding wider streets and more bridges. There has been no toll taken off or changed since that period. The toll was taken off Blackfriars-bridge during the last century. Taking the population in 1821, and supposing that the population at that period demanded two new bridges, and got two new bridges, it would then give about 250,000 as the number of the population to be supplied by one bridge. If that be taken as the proper mode of ascertaining the necessity for bridge accommodation, we ought at the present moment, in London, instead of five bridges, to have at least ten bridges to accommodate the public. One of the reasons why the streets are so crowded in the City is, that almost all our leading thoroughfares converge at London-bridge. There is a large quantity of traffic from the west going to the South-Eastern Railway, and a large quantity of traffic from the north going over the water, and they prefer the high level of London-bridge to the low level of Blackfriars; so that all from that area, between Goswell-street, round by Hackney and Limehouse, come up to London-bridge; and there is a tremendous crush in Fenchurch-street. On the other side of the river we have them coming from Rotherhithe, Bermondsey, Greenwich, Camberwell, Clapham, and Wandsworth, all crowding to London-bridge. Now the question is, how to get rid of this traffic that is every day increasing. Thinks it would fall within the scope of the inquiry of this committee to see what is done in other great cities; for instance, in New York, over the East River, and over the North River, which is four miles wide, there is a continual supply of steam ferry-boats, starting every five minutes, sufficiently large to convey ten wagons and 1000 men, if required. If there was something of that kind at the river-side, say, for example, about the lower part of the Tower, and crossing over to Dock-head, there would be a continual traffic across, and relieve London-bridge of nearly one-eighth of its present traffic. It would not interfere with the traffic up and down the river. In

New York a very light toll is levied; where the city claims the river-side, they let the ferries to parties who are disposed to take them, and permit a small toll to be levied. The number of barges coming up the Pool during a flood-tide would cause some difficulty to a steam-boat crossing the river at such a time; but that would not be insurmountable. There might be a guiding chain underneath, to enable them to go very nearly in a straight line. There is always plenty of opportunity for crossing. Was prepared to offer securities to construct the bridges which he proposes in a way that should be satisfactory to the City and to the government for 500,000*l.*; including the whole of the approaches and the whole of the land from St. Paul's Churchyard to the level of Union-street. The corporation are very anxious he believes to carry out this improvement; their only difficulty is money. London-bridge cost—removing the old bridge, 35,600*l.*; building the new bridge, 680,232*l.*; and the approaches, 1,840,436.: making together, 2,566,268*l.* Mentioned to the committee two or three points with respect to the necessity for more bridges. Any man who comes over London-bridge twice a day, must be satisfied that at least two bridges are wanted to relieve the traffic; there is quite enough traffic there for two bridges. Produced the following table of the traffic taken by twenty-four men, who were employed on all the bridges on one day last year:

*Table showing the Traffic of the Bridges.*

| | Bridges. | Ten. | Eleven. | Twelve. | One. | Two. | Three. | Four. | Five. | Six. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pedestrians. | London ... ... | 8175 | 7374 | 6885 | 6707 | 6195 | 6180 | 6651 | 7773 | 7140 | 63,080 |
| | Southwark. ... | 139 | 175 | 209 | 165 | 130 | 160 | 130 | 119 | 130 | 1,357 |
| | Blackfriars ... | 4099 | 2989 | 2925 | 3259 | 3143 | 3830 | 3296 | 3434 | 3114 | 30,089 |
| | Waterloo... ... | 681 | 683 | 689 | 616 | 610 | 636 | 705 | 817 | 797 | 6,234 |
| | Westminster ... | 2640 | 2700 | 2880 | 2980 | 2460 | 2460 | 3160 | 2900 | 3990 | 26,170 |
| | | 7559 | 6547 | 6703 | 7020 | 6343 | 7086 | 7291 | 7270 | 8031 | 63,850 |
| Equestrians. | London ... ... | 5 | 15 | 10 | 12 | 13 | 7 | 11 | 25 | 16 | 114 |
| | Southwark ... | 21 | 16 | 13 | 4 | — | 9 | 1 | 11 | 18 | 93 |
| | Blackfriars ... | 8 | 9 | 9 | 9 | 5 | 10 | 17 | 14 | 10 | 91 |
| | Waterloo... ... | 5 | 1 | 6 | 1 | 4 | 2 | 3 | 3 | 10 | 35 |
| | Westminster ... | 15 | 35 | 34 | 44 | 26 | 47 | 21 | 34 | 41 | 297 |
| | | 49 | 61 | 62 | 58 | 35 | 68 | 42 | 62 | 79 | 516 |
| Vehicles. | London ... ... | 1311 | 1248 | 1373 | 1288 | 1185 | 1092 | 1265 | 1426 | 1310 | 11,498 |
| | Southwark ... | 35 | 38 | 33 | 34 | 25 | 30 | 38 | 42 | 32 | 307 |
| | Blackfriars ... | 338 | 430 | 615 | 550 | 490 | 410 | 444 | 510 | 572 | 4,359 |
| | Waterloo... ... | 119 | 183 | 203 | 200 | 164 | 205 | 188 | 260 | 187 | 1,709 |
| | Westminster ... | 490 | 650 | 680 | 640 | 560 | 650 | 660 | 790 | 720 | 5,840 |
| | | 982 | 1301 | 1531 | 1424 | 1239 | 1295 | 1330 | 1602 | 1511 | 12,215 |

When in Paris, witness took pains to ascertain the exact amount of bridge accommodation there, and finds they have, in fact, ten times more bridge accommodation in Paris, a pleasure-taking city, than there is in London, where there is a large amount of business conducted. Thinks the principal manufacturing city in France comes nearer the point, because we find there, as in London, a large population upon one side of the river, and another large population upon the other side of the river; at Lyons, in five miles, there are twelve bridges over the Saone, and in three miles and a-half, seven over the Rhone, making nineteen altogether. At Lyons, the population is only 350,000, or about one-seventh of ours; and if population be taken as the criterion for the number of bridges required to place Loudon on a level with Lyons in that respect, there ought to be 132 instead of seven bridges over the Thames. At Glasgow, they have opened two bridges within a very short time; they opened one last year, and they are now setting to work to get another, in order to have sufficient accommodation; there we find an example worthy of being imitated. Those bridges are paid for, to a certain extent, by money borrowed upon the tolls, but there is now a movement to have them entirely free. The parties on either side of the river are to pay a small rate, and it is proposed to keep them free in perpetuity. They have three stone bridges and a suspension foot-bridge; two of the stone bridges are 60 feet wide each, and the other 40 feet wide. Now, if three bridges are required for 385,000 people in Glasgow, then for London, with a population of 2,400,000, we ought to have at least eighteen bridges to have the same amount of accommodation. The four bridges at Glasgow are within half a mile; it is not quite half a mile from the lowest to the highest. While in Glasgow they have four bridges within a space of half a mile, in London we have only five within two miles; to equal Glasgow in this respect London should have twelve bridges. It is important to know that our streets are much crowded in consequence of wagons creeping along the river side instead of getting across the river at the most convenient point. In Glasgow the aggregate width of the bridge accommodation is 160 feet; in London, from Westminster-bridge to London-bridge, we have only 220 feet of bridge accommodation. In Glasgow there is 1 foot of bridge accommodation for every 2380 persons; in London we have only 1 foot for 11,363; in other words, the population of Glasgow enjoys five times the amount of bridge accommodation provided for the people of London. London-bridge provides accommodation for at least 1,000,000, which, being only 54 feet wide, gives only 1 foot for 18,000 persons designed to be accommodated by that particular bridge; so that, whether you take it as regards population or as regards traffic with reference to the bridge accommodation enjoyed by other cities and towns, London is the worst accommodated of any city in Europe. Witness produced the following table, which, he believes, is not to be found anywhere else; had considerable difficulty in obtaining the facts, which are gathered from various sources (*see Table on next page*). At Glasgow one of the stone bridges cost 42,000*l.*, another cost 36,000*l.*, and the third cost 28,000*l.* The difference between the width of the Clyde at Glasgow, and the width of the Thames at London is about one-half. The average water-way of the five bridges in London is 800 feet, and in the Clyde it is a fraction over 400 feet. None are at present free; there is an agitation for the purpose of making them all free. Twopence pontage is levied for each cart of goods, and one penny for coals; twopence for each cab with one horse, fourpence for the carriages with two horses. Has turned his attention to the question how the expense of the proposed new bridge could be met. From the evidence given

*Table showing the Proportions, Cost, and other Particulars relating to the several Bridges.*

| Name. | Length. | Width. | Height above High water. | Arches. | Span of Centre. | Begun. | Finished. | Waterway. | Material. | Architect. | Cost of Bridge. | Cost of Approaches. | Total. | Gradients, Surrey Side |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Feet. | Feet. | Feet. | | Feet. | | | Feet. | | | £. | £. | £. | In 100 feet. |
| London | 920 | 54 | 29½ | 5 | 150 | 1824 | 1831 | 690 | Granite | J. Rennie | Removing Old Bridge, 35,000 680,232 | 1,840,436 | 2,566,268 | 4· |
| Southwark | 700 | 42 | 29½ | 3 | 240 | 1814 | 1819 | 660 | Iron | J. Rennie | — — | — — | 800,000 | 3·3 City side. 4·6 |
| Blackfriars | 995 | 42 | 27½ | 9 | 100 | 1710 | 1769 | 798 | Portland Stone | R. Myine | — — | — — | 210,000 | 3·10 |
| Waterloo | 1326 | 43 | 27½ | 9 | 120 | 1811 | 1817 | 1080 | Cornish Granite | J. Rennie | — — | — — | 1,000,000 | 3·0 |
| Westminster | 1220 | 40 | 25 | 15 | 76 | 1739 | 1750 | 820 | Portland Stone | Labeyle | — — | — — | 388,700 | 3·9 |
| | | 221 | | | | | | 4048 | | | | | | |
| Proposed, St. Paul's | — | 60 | 27½ | 5 | 240 | — | — | 960 | Iron | — — | 144,000 | — — | — — | 2·6 |

Average Width of Waterway, 800 feet.

by Mr. Brand, it appears that the Bridge-house Committee have now at their command about 230,000*l.* They have borrowed 431,000*l.*, and rather more than one-half the time of the annuities has expired, and that amount might be considered a very fair contribution for the City of London. Does not think that there is any body in existence at present that could be trusted with the levying of a rate; thinks it would be proper to have in London, as they have in Glasgow, a river trust, which, he believes, is composed partly of gentlemen and merchants, who use the river; a certain portion of the corporation form another part of the trust, and other persons appointed by the counties form another part; the whole being twenty-four persons in number; they form the river trust, to whom the management of the banks of the river, and the bridges, and everything of that kind is entrusted. Something of that sort might be done in London; the Corporation of the City of London, and the counties of Surrey, Kent, and Middlesex, might each delegate a certain number of members to form a certain trust, a bridge commission, for the express purpose of conducting these matters, and be vested with powers to levy a rate upon the population which they represented; or, if we have before long the whole metropolis divided into corporations, as has been elsewhere suggested, the thing would be easier done. As part of his scheme, suggests that a street should be carried straight to the Elephant and Castle. His belief is, that properly managed, the property so taken, being comparatively valueless at present, would increase so largely in value, that the ground-rent would, to a large extent, pay for the compensation given for the land. A wide street on the south side of the river, from Westminster to London-bridge, into which all lateral traffic would fall, if made wide enough—70 feet at least—could not fail to be of immense advantage. Thinks that a new road passing along the Surrey side is an exceedingly good plan for accommodating the traffic to the railways; but it would be still better if the South-Western Railway were to come to the point of the new bridge, opposite St. Paul's, and if the South-Eastern should have a branch to the same point for the accommodation of persons seeking that quarter of the city, and still more for the economy and convenience of our continental and colonial postage. By such an arrangement the mail-train might start an hour earlier every night, and the distance between London and Paris be shortened by an hour.

Walker, James, V. P. Inst. C. E., Consulting Engineer to the Navigation Committee.—The existing bridge accommodation of the metropolis is less than is requisite; the immediate remedy is to make those bridges that are now toll-paying bridges free. His reason for saying so is, that the collective width of road of all the free bridges over the Thames is 138 feet; and if a reference be had to the capabilities of the present bridges, and also to the alterations that are about to take place in them the collective width of thoroughfare might be increased 150 per cent. of its present amount, that there might be 323 feet. A favourable opportunity is now offered of purchasing the toll-paying bridges. A rate levied within a radius of ten or twenty miles of St. Paul's would be the best method of raising the purchase-money. Considers it more expedient to purchase Southwark-bridge than to build a new bridge to compete with it. The fairest manner of assessing the sums to be paid for the different bridges, would be to throw them open for a year, to ascertain the traffic. A bridge coming near or through Northumberland House, opening into Trafalgar-square, is much to be recommended; there is a greater distance of the river between Waterloo and Westminster bridges than anywhere else lower down; the distance between them by water is three-quarters of a mile, and one mile by the Strand. Thinks the Cannon-street improvements will give very great facilities to the communication over Southwark-bridge. Presumes that to consider what the bridge companies make now is a narrow way of looking at it as the purchase price; as the population increases so does the value of the property. The limited navigation of the Seine renders the erection of bridges easier than over the Thames. The width of bridges over the Clyde at Glasgow, one of which is just finished, is greater than that of free bridges over the Thames. London-bridge could not be widened as suggested without destroying its architectural beauty; he has no doubt that it could be done as regards solidity. The throwing open Southwark-bridge will relieve the inconvenience more than that of Waterloo. The approaches to Southwark-bridge might be made better at a comparatively small expense. To effectually improve the approach would be to make an archway as was done at London-bridge, and pass the traffic under it, but that would be a very expensive affair, now the inclination on the Middlesex side is too steep. The approach on the Surrey side is much better, being 1 in 30½. On the Middlesex side, thinks the inclination could not be improved without a considerable outlay; it is now only 1 in 20, not much steeper than Westminster, which is 1 in 22; a length in the approach to London bridge is 1 in 25; Ludgate-hill is 1 in 27, Vauxhall-bridge only 1 in 35. Does not know any improvement more desirable than an improved communication between the Surrey side of Waterloo-bridge and Union-street, Borough, there would then be a good communication all the way from Westminster-bridge to London-bridge.

McClean, John Robinson, C.E.—The only way to improve the bridge accommodation is to divert the traffic as much as possible. Widening the bridges will not alone accomplish the object of facilitating the course of traffic. Proposes to build two bridges, instead of rebuilding Westminster-bridge, one commencing at Charing Cross, close to the Duke of Northumberland's, and terminating in the Westminster-bridge-road at its junction with St. George's road. The second to be placed at the south end of the Houses of Parliament, near the end of Great College-street. The expense would be 1,500,000*l.* for the two, including the approaches. Would prefer a new bridge at Charing-cross to purchasing Waterloo-bridge. The funds for erecting the bridges could be raised by a rate on the counties of Middlesex and Surrey. A rate of two-pence in the pound would provide the means of building the two bridges and throwing open the money-paying ones. More bridges are preferable to widening existing ones.

Bateson, Samuel, C.E. and Architect.—Has particularly considered Blackfriars-bridge. Was led to thinking of it by having made a design for Westminster-bridge. Was led to that by having made previous designs for bridges. The subject was given by the Society of Arts some time ago, and witness sent in a design to them which he afterwards endeavoured to adapt for Westminster-bridge, and submitted it to the committee; but the design having been decided upon for that, he has endeavoured to adapt it to this. Retaining the three arches on either side, the expense would be 125,000*l.*, but calculating the whole bridge it would come to about 300,000*l.* Proposes two plans, one for widening the old parts of the bridge and the renewal of the remainder, the other a new part altogether. In the first increases the width from 42 feet to 70 feet, at an expense of 125,000*l.*, retaining three arches on either side. Is informed that three of the arches on either side are defective, and in consequence has designed an entirely new bridge of iron on stone piers, on a plan which would make the width 100 feet, and give two roadways of 35 feet each.

## MUNICH INDUSTRIAL EXHIBITION OF 1854.*

The building appeared appropriate to its purpose, and was generally admired. It was in the form of a cross, and was constructed of iron, glass, and wood, from the design of the architect, M. de Voit, of Munich, by the contracting builder, M. Cramer-Klees, of Nuremberg. The site chosen was the northern side of the Botanical Garden. The length of the main edifice was 800 Bavarian feet,† and that of the main transept 280 feet. The greatest height was 87 feet. The following is a correct statement of the space which the building afforded:—

| | | |
|---|---|---|
| | | Square feet. |
| Superficies of the glass hall (main building) | | 216,800 |
| Superficies of the adjoining engine-room | | 23,210 |
| Superficies of the adjoining room for agricultural implements | | 17,204 |
| | | 257,214 |
| Deduct for offices and staircaises | | 23,210 |
| Space for the Exhibition | | 244,814 |
| | Square feet. | |
| Of which the floor took | 64,556 | |
| the tables | 60,672 | |
| the passages | 119,586 | |
| | | 244,814 |
| The walls or sides took | | 48,927 |

The average space allotted to each exhibitioner (taking the number of exhibitioners at 6800) was calculated at about 18 square feet of flooring and tables, and 7 square feet vertically, making in the whole somewhat more than 25 square feet. The general effect upon the observer from within was undoubtedly good; but the pillars being of wood, not iron, was a circumstance which rather detracted from its general elegance and lightness. The entire of the cost of the building is stated to have been 180,000 florins, or about 88,000*l.* sterling.‡

* From the report of Consul-General Ward to the Earl of Clarendon.
† 100 Bavarian feet are equal to 95⅔ feet English measure.
‡ 1 florin of 60 kreuzers is equal to about 2*s.* sterling.

*Appointments, &c.*—Mr. John Whichcord, F.S.A., F.R. Inst. B.A. has been elected by the Justices of Kent, District Surveyor of Deptford. The following gentlemen were also candidates:—Messrs. Williams (second), Henry Jarvis, Edwin Nash, George Barnes, Legg, and Pring.

## THE NEW NORTH BATTERY, LIVERPOOL.

The new battery which has been built to the front of the river north-west of the Huskisson Dock, from designs by Captain Westmacott, is ready for the reception of the guns and Ordnance stores. It has been constructed by Messrs. Arthur and George Holme, of Liverpool; the principal material employed being Runcorn stone. It is a square building, occupying about 3000 square yards, and having been erected in the castellated style of architecture, it presents from the land side a handsome and substantial appearance. The battery fronting the river is completed, and ready for the reception of ten 32-pounders, with which it is to be mounted. At either end, and also facing the river, is placed a tower of solid masonry, on each of which will be mounted a 68-pounder, so arranged as to sweep the river in every direction. The steps by which access is obtained to the guns are of Irish granite. The parade is a fine open area, almost square, enclosed by the various accessory buildings requisite in connexion with a defensible construction, entrance to which is obtained from the east side by means of a drawbridge, suspended in the usual manner over a deep ditch or artificial fosse. On either side of the arched entrance are a series of apartments, to be used as quarters for the officers and men, a school-room, magazine, &c. These buildings are protected by a roof of great strength, covered with Seyssel's asphalte, and made bomb-proof. The battery is capable of defence in every direction, facilities being provided for mounting guns on all sides. It is capable of holding a garrison of 500 men, and, as a protection against privateers, will be found to answer the purpose for which it has been constructed. Beyond that it would be but of little use. The chimney-pieces, shutters, racks for the guns and cutlasses, and, indeed, nearly all the fittings, are of wrought iron. In the centre of the parade there will be two large tanks; and a lightning conductor will be placed near the magazine, which is protected by a brick arch, of great strength, made bomb-proof.

## THE DRAINAGE OF TOWNS.

### By Robert Rawlinson, Assoc. Inst. C.E.

[*Paper read at the Institution of Civil Engineers.**]

The Drainage of Towns is so comprehensive a subject, that its full and complete treatment, within the limit of a communication to be read at one evening meeting would be a useless attempt; the object of the present paper therefore is restricted to furnishing topics for a discussion, during the course of which it may be anticipated that the merits and demerits of the different systems of sewerage will be fully developed and freely canvassed.

Town drainage may be considered historically, politically, and socially. The historical portion of the question need not be entered into further than to say, that remains of what appear to have been drains are found in the long buried cities of Syria, and the sewers of ancient Rome partake of the fame of "The Eternal City;" indeed, the Cloaca Maxima is asserted by some authors to have been the work of a people older than Romulus. Livy, however, gives the reign of Tarquinius Superbus as the date of its formation.

Politically, the question of the best system of town sewerage and house drainage is very urgent, and at no period has it ever been of greater importance than at the present time. It may be clearly shown that the progress, if not the permanence, of civilisation is dependant upon a correct appreciation of its merits; as the healthy existence of town populations must ever be influenced by their sanitary condition. Misery, pauperism, vice, and crime find a forcing-bed in the unsewered parts of towns, and amidst the foul air of undrained houses.

This may not be self-evident on a cursory consideration, but facts and figures which will not admit of contradiction, can be brought in aid of the assertion.

The tendency of modern civilisation has been to congregate the human race in masses, and in Great Britain the extension of towns is unprecedented. In 1841, the population in one hundred and seventeen districts, comprising the chief towns, was 6,612,958 souls. In 1851, in the same districts, the number was 7,795,882, being an increase of 1,182,924 in ten years. When it is remembered that the greater portion of the area thus populated is comparatively low and flat, such as in seaports, on the banks of inland rivers, or in valleys intercepted by canals, it is not surprising that this crowding should produce disease, as is proved by the almost constant presence of fever, and a recurrence of the more deadly cholera. It is quite true that disease, in some terrible form or other, has ever been associated with man when thickly congregated,

*Excerpt 'Minutes of Proceedings of the Institution of Civil Engineers,' Vol. XII. Session 1852 53. Edited by Charles Manby, F.R.S., M. Inst. C.E., Secretary.

whether in cities, in towns, or in armies—but it may also be shown that much of the disease has been of that class which, by due precaution, might have been averted. A full elucidation of this portion of the subject belongs rather to the medical department than to that of engineering; it may, however, be stated that the averages of mortality, though much higher in town than in country districts, do not reveal the worst feature of the case, as the annual number of deaths in the most unhealthy parts of a town are frequently as ten to one, compared with the better parts of the same town. That is, if ten out of each thousand die annually in one district of a town, one hundred out of each thousand perish in another quarter of the same place; so that a statement of any given average of deaths per thousand would be liable to mislead. The average number of deaths in English towns ranges from twenty to thirty per thousand. In country districts the average does not exceed seventeen or eighteen per thousand; and amongst the well-regulated classes only about ten to fifteen deaths per thousand occur annually. In the convict prison, on the Isle of Portland, the annual average of deaths is only about five per thousand. There are, however, in that establishment neither infants nor very old people to swell the mortality.

This portion of the subject may be closed by a quotation from a valuable report on cholera in England, recently issued by the registrar-general, in which he says:—"A large portion of the next generation of Englishmen will be born in town districts, some of which are high and healthy, while others, low, insalubrious, subject to inundations, and to the incursions of cholera, present many of the circumstances in which a degradation of race is inevitable. In the dense districts of Lancashire, where the health of parents is depressed, and the circumstances are often so prejudicial to their offspring, that of the coming generation five, instead of two, of every ten born are destroyed in the first five years of life, and the survivors, with a few happy exceptions, are left with shattered, feeble, febrile, and disorganised frames—degeneration is as inevitable as the degeneration of horses, oxen, and sheep in circumstances equally unfavourable." The might of a nation consists in the health and strength of the people; therefore the supremacy of a country is, in a degree, dependent upon its general sanitary condition.

It is, however, to the social effect of town drainage that the attention of civil engineers will be most naturally directed, as under that head the leading principles of actual practice, and those modifications which have been proposed for adoption, must be brought forward and discussed. So much has been recently said and written upon town drainage, that it will be quite impossible to strike out either a new or an independent course, nor is it advisable to do so, as to study precedent, to learn from experience, and to correct from practice, are the chief duties of an engineer.

The much-disputed question of, "In what good town drainage consists?" can only be answered by the exhibition of actual works which do fully answer their intended purpose. The forms and dimensions of sewers, the materials of which they may be constructed, and the depths below the surface at which they should be laid, admit of some moderate difference of opinion, but certainly not to the extent now permitted in practice. In one position a brick sewer 5 feet high by 3 feet wide will be constructed at about 2*l.* 10*s.* per lineal yard, whilst in a similar situation there will be laid down an earthenware tube 1 ft. 3 in. diameter, at an expense of 8*s.* or 10*s.* per lineal yard. There must be something positively wrong in such discrepancy of practice as this, and the sooner the truth is discovered and proclaimed the better will it be for all parties. If that man is a benefactor to his race who makes two blades of wheat grow where one only grew before, he is likewise so, in a degree, who constructs two lineal yards of effective sewer for the price that has before been expended upon one yard; if the cheaper sewer performs its functions more or even as perfectly, then is the achievement so much the more worthy; but if it does not perform so well, then the innovation becomes an injury.

It has been asserted that no street sewer ought to be less than will allow a man or a boy to pass along it. The legislature has passed an Act to prevent boys being sent up chimneys, and, better arrangements being made for providing water for flushing, it may some day be inclined to pass an act to prevent men from entering sewers. The latter will be more humane than the former, as it is asserted that more lives have been destroyed in foul sewers than ever were lost in crooked chimneys.

In town drainage there are three primary considerations:—

1. The line for the outlet sewer or sewers, if more than one such be necessary.
2. The dimensions of these outlet sewers and their form.
3. The materials of which sewers may best be made.

The position of the outlet or outlets will in some measure be governed by natural conditions. They must be in such a relative position as shall least endanger health; and wherever it is practicable only one outlet should be formed, as the refuse will then be concentrated, either for natural removal or for agricultural use.

The size of outlet-sewers must be fixed by the number of houses to be drained, and the extent of the area upon which they stand.

The site to be drained may consist of flat alluvial land, impervious mud, or pervious gravel shingle; or the town may stand on the banks of a tidal river, the surface being very little above the high-water line, or it may be actually below the level of high-water of spring tides. Then there are inland cities and towns, through a part of which flow rivers liable to excessive land-floods, and the waters may be impeded by locks for the purposes of navigation, and by weirs for mills.

The site to be drained may be partially a flat plain and partially rising land inland, showing a tolerably straight front, or being convex towards the plain. The land may rise on both sides, as in a creek or bay, or may consist of several such creeks, with natural watercourses passing through each, bringing down the surface waters of suburban areas much larger than the town itself; these and other innumerable combinations, which need not be specified, are all questions, for the treatment of which no fixed rules can be given; each individual case will demand especial study, and must have local knowledge and care.

That the question may, however, be discussed, certain rules relative to town sewers will be assumed, which may or may not be established.

1. They cannot receive the excessive flood-water even of the urban portion of the site.
2. They ought not to be combined with the natural watercourses which drain large areas of surburban land previous to entering the urban portion.
3. They should be adapted exclusively for removing all the liquid and soil refuse from the houses in such a manner as to cause the least possible nuisance to the inhabitants.

Where the site of a town is a plain, only little elevated above the tidal water-line, the delivery of the refuse from the sewers must either be by pumping to render it constant, or it must be intermittent, and therefore leaving the refuse for a time stagnant in its channels of conveyance. Sewers and drains are frequently required in situations where high tides, land floods, or both combined, cover to a considerable depth the surface beneath which such sewers must be laid; or if the area is embanked, the waters rise above the level of the land and the outlet. These circumstances frequently serve as excuses for not attempting the formation of any sewers or drains, and most certainly it is much safer to the inhabitants that there should be no sewers, than that there should be sewers of deposit. That towns so situated may, however, be perfectly and even economically drained, is proved by the condition of Holland, where the land is almost all below the level of the sea, and yet it is the most densely-populated country in Europe. In England, great portions of Lincolnshire, Cambridgeshire, and other counties, with large areas of agricultural land only worth from one hundred to two hundred pounds per acre, are drained either by intermittent action or to a great extent by pumping-machines, designed by and erected under the direction of members of this Institution.

That which is done profitably for agricultural land may assuredly be carried out for town sites, where the intrinsic value of the land and of the property placed upon it (exclusive of the importance of preserving human life) is in many instances as one hundred to one, or even more.

Inferentially, it may therefore be stated that town sites may be profitably drained by pumping, independently of any commercial value attached to the sewage refuse.

Where a town site is partially a plain and partially rising ground sloping towards the level or low portion, the formation of intercepting lines of sewer to receive the contents of the sewers and drains of the higher portion, and to prevent their falling into the lower level, will save much pumping.

The sewers formed in level or low districts should be of minimum dimensions; they should be laid as near the surface as is consistent with their safety, and should be constructed of a material capable of bearing external pressure without crushing, and internal pressure without leaking or bursting. If sewers connected with a pumping establishment are much larger than corresponds with the lifting power employed, the current through them will be sluggish, and deposit will take place. It will be evident that such sewers should not be unnecessarily deep, in order that the artificial lift should be as little as possible; and they should be capable of resisting hydraulic pressure, as they will be liable to be filled above the crown, either through an extraordinary rise of tide or through heavy land floods. This latter consideration involves the question of sluices and valves, which, however, need not be entered upon in this paper.

Another reason why sewers in flat districts liable to surface flooding should be of minimum dimensions is, that maximum volumes of water in such places cannot be provided for in sewers. The river Eden, at Carlisle, rises about 20 feet, and the river Ouse, at York, rises about 18 feet above summer level, laying under water areas of many miles square. Large sewers in such districts would give no relief at such times, and in dry weather they would be a nuisance.

The assertion that "town sewers should not receive suburban waters or excessive suburban rain-fall," requires some explanation. The area drained by natural streams may be much larger than the urban area, and therefore any arched channel or sewer to convey away safely the flood waters of such a district must be in proportion to such area; the cost of course being in proportion to the sectional dimensions of the tunnel or sewer formed. Another consideration which ought also to have great weight is, that the flow of flood waters is intermittent, whilst the flow of sewer waters should be constant—that is, the sewers should be as much as possible self-cleansing, by the daily action of the fluids passing through them. This cannot be the case if a small body of water is spread out over a wide bottom or invert. There must in such a case be a deposit, which will be increased by such obstructions as stones, sticks, road-sand, gravel, &c., which will be carried from the open watercourses into all sewers or tunnels receiving the flood waters of a suburban district, because the channels leading to the sewer and the end of the sewer itself must be open. The stagnation of sewage refuse in such places will also be greatest during the driest period of the year, when the evaporation will be most injurious.

Several reasons may be given for the assertion that "sewers, other than main outlets under particular circumstances, should not be calculated to contain the flood-water of an excessive rain-fall," though one only ought to suffice—namely, that the waters of an excessive rain-fall cannot be passed through any ordinary gully-grates into the sewers. In Birmingham, on the evening of Sunday, the 6th July 1845, there fell 1·945 inch of rain in little more than half an hour. This was equivalent to 9·091 gallons upon each square yard of surface, or 44,000 gallons to each statute acre. This is no doubt such a flood as is seldom met with, but equal volumes of rain have fallen in the metropolis and in other places in England. Those who have any given area to drain for town purposes, taking these figures as multipliers will ascertain about the maximum if they premise that sewers ought to be of sufficient capacity to receive the storm waters and to retain or pass them off below the level of the cellars. In many cases the storm waters will pass over the surface after the formation of sewers just as they flowed away before the construction of any artificial conduits.

The dimensions of sewers ought in some measure to fix their depth below the surface, as there ought to be a fall of not less than one in sixty from the deepest house or cellar drain to the highest water-line to which a sewer can safely be allowed to be filled.

In arranging a system of town drainage an engineer must consider the following questions:—

1. How has the flood water hitherto passed away, seeing that there never has been such a work as a sewer in the district?
2. What has been done on the surface, in the formation of quays, roads, or streets, or in any other way to impede the free escape of the surface water?
3. What are the effects experienced during land floods?
4. Is it practicable to construct sewers large enough to pass the whole volume of a maximum rain-fall at such a level as shall not inundate the cellars with back-water?
5. What additional length of outlet will be involved to secure the fall required for large and deeply-laid sewers?

These are all questions of the utmost importance, involving economy and efficiency, but there are other minor questions which an engineer should settle before finally deciding on a system of town drainage.

There are sites upon which houses ought never to have been built, and cellars have been dug where the natural outlets upon the surface have been contracted or destroyed, instead of being preserved and improved. In such cases an engineer should constitute himself nature's journeyman, and by carefully observing the natural features of the locality, and using them as much as possible, attain his end more readily than by attempting any forcible control.

There are cases in which it is the province of an engineer, in some degree to oppose nature, but this must ever be a costly and dangerous undertaking, and nothing short of actual necessity will justify the attempt. The greatest men in the profession have shown, by their works, that they never undertook an opposition course, when they could accomplish their purpose in an easier manner.

In town drainage, nature must first be consulted, and effective assistance may then be given to her operations at the least cost. Where there has never been a sewer, it may not be considered necessary to construct one 5 feet deep by 3 feet wide, at a depth of some 15 feet, or 20 feet below the surface of the street, to the great danger of all the adjoining property, and, in many instances, to the certain destruction of the natural outlet.

If it shall be decided, the town sewers are not to convey away the drainage waters of suburban districts, and if it shall further be granted, that they cannot be made of sufficient capacity to contain even the urban waters, during maximum rain-floods, it may naturally be asked, of what dimensions should town sewers be constructed? and this may be partially answered by considering the principal intention in constructing town sewers.

If it be for house and yard drainage, then to these they should be adapted, —and there will be reliable data from which to calculate their dimensions. The sewers and drains will be of minimum size, and will, consequently, not require either very wide or very deep excavations to be made, and the cost of the work will also be reduced to a minimum.

It will be admitted, that many large sewers were not originally constructed to serve the purpose to which recent practice has adapted them —namely, to receive and convey away the contents of water-closets for an entire population.* The assertion may sound strange to the dwellers in this metropolis, where the practice of water-closet drainage has prevailed for some time; but few even of the metropolitan sewers were designed solely with reference to house-drainage. This duty has been subsequently imposed, but even now there are miles of sewers which do not receive the drainage of one-tenth of the houses in the district.

In Paris the contents of water-closets are generally excluded from the public sewers, and it is only recently that the law has been repealed in Liverpool, forbidding the turning of water-closet refuse into the sewers. The architect of St. George's Hall was obliged to arrange for the construction of large cesspools beneath the foundations, to receive the contents of the water-closets proposed to be erected in that building.

There are, in many towns in England, great lengths of sewers, which do not receive the adjoining house-drainage.

In discussing the best form for sewers and drains, it is necessary to consider carefully their dimensions, and the materials of which, under all local circumstances, they can most advantageously be made. The nature of the subsoil must first be well ascertained, before either the form or the material can finally be decided upon; that is, the engineer will frequently have to modify both the form and the material, in order to overcome some natural difficulties which could not be foreseen, but which will induce more or less alteration from the first design, and not unfrequently occasion even partial failure in the works of the ablest and most watchful engineer.

In existing sewers and drains may be found almost every sectional form, of which such constructions are capable; they are V shaped, square, oval, and circular, and also partake of every intermediate combination of these figures; V bottoms have been defended; flat floors, or inverts, have been advocated, and the egg shape has been insisted on, even down to drains of 4 inches in diameter. There have been as varied assertions, relative to diameters; but that question need not be discussed here, as actual works, the great test of engineering, can alone give a practical solution to this question. Beyond all dispute, there are many miles of sewers in existence, very much too large, and there may be some too small.

Rules have their use, and that man who works without rule will seldom be right; but he who works by rule alone may also sometimes be wrong.

Rules for the diameters of sewers and drains, to remove, not only the ordinary flow, but also the storm-water of districts, have recently been published,* and, as these rules are within the reach of every member of this Institution, more need not be said relative to them, at present.

If the materials of which sewers may be constructed, are to be subjected to local contingencies and conveniences, the sectional forms may be more definitively settled.

Sewers, having a transverse sectional width of more than 2 feet, should have a circular invert, in order that the minimum flow of water may be concentrated.

For sewers, less than 2 feet in diameter, the strongest form is the circle, whether they be constructed of pipes, tiles, or bricks. There may be an advantage in the egg shape, when sewers exceed 2 feet in diameter, but practically that form possesses none for lesser dimensions, and should not in practice, be adopted for small sewers or drains.

The best material for the construction of main sewers, is a question only to be determined by practical results. Brick, stone, and cast-iron, either used singly or variously combined, have each their partisans; recent practice has however indicated earthenware pipes as (apparently) the most economical and effective, for all sewers and drains, under ordinary circumstances, and within the capacity of the material. They have been made from 3 inches up to 30 inches in diameter; the former are too small for any drain,—the latter are too large for the material of which they are made.

It is self-evident, that theory alone cannot be followed in determining the sectional area of house-drains; if it were they might be reduced, in some cases, to the size of a quill, as more water will pass through such an aperture in the course of twenty-four hours, than is used in a cottage; but drains are devoted to other uses than the mere passage of fluids through them, and their sectional dimensions must be adapted accordingly. It will probably be eventually shown, that 4 inches in diameter is the minimum sectional area to be given to house-drains, and that they should not be laid at a less gradient than one in sixty.

This question of size may, however, now be left to be settled by practice; discussion rarely makes converts; but facts are stubborn things, when they can be arrived at without any colouring of prejudice.

The theory of pipe-sewers has been recently much agitated, and without undue advocacy of extreme views it may be asserted that no discovery of modern times is more fraught with benefit, if properly applied, than the use of pipe-sewers for town and house drainage. Streets have been effectively sewered, and houses efficiently drained, by earthenware pipes, where neither sewer nor drain would have existed, if costly brick constructions had alone been available.

Earthenware pipes cannot, however, be beneficially used as sewers, beyond certain limits, which can only be settled by practice; temerity will lead to failure, and failure will correct theory. The engineer who is anxious after truth will not denounce a system, because some men push it to extremes, and hence he will use the mistakes of others as his beacons.

* The Cloaca Maxima was designed and used by the Romans for conveying away both fluid and solid sewage.

* Vide "Minutes of Information on Sewerage and Cleansing of the Sites of Towns;" General Board of Health Reports. 1852. Page 67.

Various forms and modes of jointing earthenware pipe sewers have been tried; there are plain ends or "butt-joints," rebate-joints—full-socket joints—and half-socket joints. There are also both circular and egg-shaped sections. About fifty miles of pipe sewers are laid in Manchester, the majority of which are egg shaped, with plain or "butt" joints finished with clay. These pipes range from 4 inches to 30 in height and are laid with the narrow side down. In twenty-five miles of main sewers also laid with pipes, there has not been a single case of failure, and in the lateral drains, wherever a few failures occurred their causes were easily discovered; indeed at Manchester, the pipe sewer system may be said to have proved most successful, and in a recent report of the town council it is stated, "The economy effected by the use of tubular sewers is palpable, and the result will be, no doubt, a great extension of the practice of draining and consequent improvement of the public health."

The maximum dimensions of pipe sewers must be governed, in some measure by contingent circumstances. At present 15 inches or 18 inches diameter is the extreme size to be recommended for socket-pipes, and in laying these great care must be taken, or through unequal bearing, the pipes will break each other at the the joints.* Pipes with plain ends may be laid of as large dimensions as the material of which they are made will allow; care being taken to secure fair fitting and equal joints. Full-socket or half-socket pipes of 12 inches in diameter and under, may be used with advantage; where they are restricted to these dimensions, the pipes are much more uniform in shape, the relative strength of the material is much greater, and there is little danger of such pipes fracturing each other. The difficulty in moulding, drying, and burning pipes increases probably as the squares of the diameters. If large pipes are moulded too thin the finished sewer is liable to be crushed, and if they are moulded of extra strength the wet pipe collapses by its own weight in drying.

The side-junctions as moulded by the best makers are a great improvement upon the direct entrance of brick sewer branches, at right angles with the mains. A well-made pipe-junction increases the velocity of the current, by passing the sewage into the main in the direction of the flow, and all side junctions should have a quick descent for the last 3 or 6 feet before reaching the main.

Good and cheap sewers may be made with either solid or hollow radiated bricks, having their beds in the radius line of the curve. Bricks of this description cost very little extra; they may now be moulded of such dimensions as are required; for instance, sewers of 2 feet diameter may be made with bricks 4½ inches on the bed; those of 2 ft. 6 in. diameter, with 6 inches on the bed, and those of 3 feet diameter with 7 inches on the bed, and so on upwards; the limit being the capability of moulding the bricks with economy and of the workman handling them with facility. Hollow bricks may be used advantageously for the external ring of sewers constructed of more than one brick in thickness; the horizontal perforations forming channels for the land drainage.

Sewers of radiated bricks set in cement are cheaper than large pipes; that is, a brick sewer of 3 feet in diameter is cheaper than one of pottery 20 inches in diameter; the capacity of the sewers being as the squares of the diameters. There is no reason why brick sewers may not be made as smooth and as impervious to wet, as pottery pipes—either by selecting bricks of peculiar quality or by having the surfaces prepared with asphalte. It is difficult to arrange perfect side junctions in brick sewers, as every inlet should curve in the direction of the sewage flow: but pottery junctions may be worked into the brick sewers or in some cases cast-iron inlets may be used.†

In a system of sewers and drains, man-holes, at intervals will be of great service. These may be simple shafts of brickwork 2 ft. 6 in. or 3 feet in diameter, carried up over the line of sewer; if placed at intervals of one or two hundred yards apart, they enable the engineer to examine the action of the sewers, and should a stoppage take place, the exact spot is more readily indicated and discovered. They are especially useful at street junctions.‡

Street gullies are generally trapped, and there is a receptacle for the heavy detritus of the roads. Here again local contingencies will affect the application of rules. Small towns with paved streets where there is little wear and a good fall for the sewer, need not have any elaborate gully arrangements; the surface water may pass at once into the sewer, or into a well, or receptacle for the grit, out of which a plain bent pipe passes to the sewer, which latter will be all the gully arrangement required. Gully-grates should be tolerably fine, that is, the apertures should not exceed ¾-inch, and if there is a kerb-stone the grate may dish towards it and be continued up the side; so that, should the surface become choked, the water will pass off by the vertical side. Large openings into pipe sewers should not on any account be permitted.*

Sewers which require trapping are either faulty in construction or their action in use is imperfect. House-drains may be trapped by a plain bent pipe; mechanical traps of every kind ought to be avoided, they are a delusion and a snare; hinged traps impede the flow of sewage and do not prevent the escape of foul gases.

There should be full and free ventilation of the sewers at all the highest and most convenient points of a town, and where any escape of foul gas will be the least nuisance. Ventilating chimneys may be of much service in flat districts of great extent, or the steam jet may be applied; but furnaces should be used with caution, as the gases of a foul sewer are liable to explosion.

In some districts cast-iron pipes may be used for sewers with great advantage, as for example, where there is partial flooding by land-floods or by tides; or, in heavy ground in quicksands, and to cross intervening spaces, where towns stand upon alluvial shingle within tidal influences. Externally they may be laid in clay,—internally the metal will be protected by the fatty matter of the sewage.

The question of town sewerage or drainage, has of necessity been very briefly and imperfectly treated in this paper. Each branch of the subject might be made a text, which would require an entire essay, with many diagrams for its illustration; but as the author's principal object has been to elicit opinions in a discussion, he has merely ventured to treat generalities.

Certain rules may, however, be given for town drainage:—

Sewers should be below the level of cellars, and they should be adapted to the especial work they have to perform.

Rivers, brooks, and natural streams should not be made a part of a system of sewers, and the sewers themselves, in low districts, should be capable of resisting internal pressure.

Wherever it is practicable, the sewage of high districts should be intercepted, so as to preserve a free outlet at all times for this portion of the system.

Small sewers and drains should be circular; large ones should be oval, or egg-shaped.

The longest practicable radius should be adopted in laying out curves on lines of large sewers, and there should be an extra fall in the curve, especially at a junction with a main sewer. All sewers and drains should be impervious to water, and should present even and smooth surfaces; special arrangements being made for land drainage.

The gradient, or fall of large sewers, in steep ground, should be modified; that is, the gradient should be interrupted, or the sewer should be made of such material as will resist the tendency to rapid wearing away.

Wherever it is practicable, the outlet, or delivery of sewers should be free, and in every case there should be full and free ventilation.

Cesspools within a town, and either beneath or attached to houses, are subversive of sewerage and drainage; indeed, no town or city can be considered as drained, in which cesspools are pérmitted to exist.

Cesspools, or manure tanks, at or near an outlet, are nevertheless admissible; care being taken that such outlet or delivery of the sewage refuse is not blocked or impeded, and that there is no in-draught or back-draught through the sewers.

The true purpose of town sewers is the instant removal, from the vicinity of dwelling-houses and from the sites of villages, towns, and cities, of all refuse liable to decomposition, and which is capable of being conveyed in water. The more fully this is accomplished, the more perfect will be the system. Efficiency, durability, and economy should never be lost sight of, and though the drainage of towns may not, at first, appear to be an attractive occupation, yet if the works are well designed and executed, it will neither be the least noble nor the least useful pursuit of the Civil Engineer.

Mr. Rawlinson admitted that his paper might be considered loose and discursive, but he had written it chiefly for the purpose of eliciting opinions on a question of great social importance, and he was ready, in answering the questions put to him, to afford any additional information in his power. It might be said that there were some positions unduly assumed; if so, they would be overthrown, and the erroneous conclusions would be pointed out.

Perhaps the best method of opening the discussion was to state a few facts in connection with the drainage of a town, where, from local circumstances, only earthenware pipes had been used. He alluded to the town of Hitchin, where upwards of 60,000 feet of pipe sewers, from 20 inches down to 4 inches diameter, and 2 ft. 6 in. long each, had been in action for four months with perfect success; the average depth below the surface was 8 feet, and the outlet of the main sewer, which was 5000 feet in length and only 20 inches in diameter, was laid in part beneath the bed of the river, at an inclination of one in eight hundred. This was designed for the sewerage of one thousand houses, of which only two hundred were at present connected, and for eleven hundred acres of urban and suburban drainage. He admitted that some of the pipes laid

* In recent practice, the author has discontinued the use of full-socket pipes, above 9 inches in diameter, and has either adopted half-sockets, or used butt-joints laid on earthenware chairs. Unequal bearing at the joints has chiefly caused the fracture of the pipes, which has been so much complained of, and which should be specially guarded against.

† Since this paper was written the author has used stone inlets. The beds of the stones are worked to suit the radius of the brick sewer, and the inlet for the pipe drain is formed out of the solid stone. Messrs. Doulton have since made a pottery inlet, which must supersede the use of stone.

‡ In all the work done since this paper was prepared and read, the sewers, whether of brick or of pipes, have been laid in straight lines, from point to point, in lengths as great as were practicable. At the change of direction or of gradient, there is a man-hole, or hand-hole, to allow of examination, so that the light is never lost through a sewer.

* A gully grate has been invented and used by the author, which effectually traps the drain, and yet allows a direct communication with the sewer. It enables the drain or sewer to be flushed with the full force of any water at command, as a hose-pipe can be passed direct into the drain leading to the sewer.

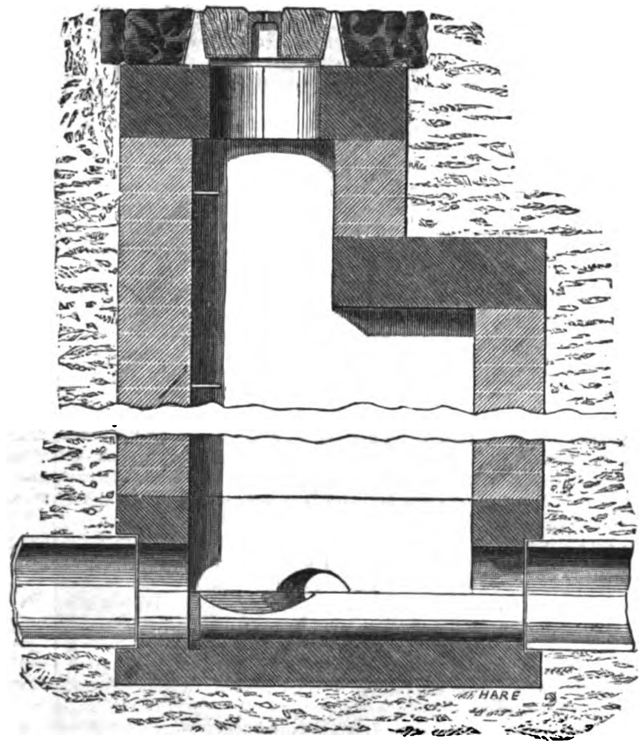



Fig. 1.—Manhole, with Junctions in Pipe Sewer. Section on the line A A, of Fig. 2.

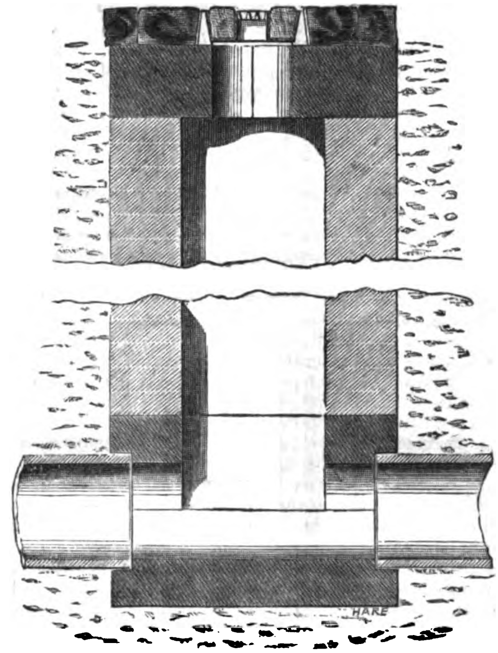



Fig. 3.—Lamphole on Pipe Sewer. Vertical Section.

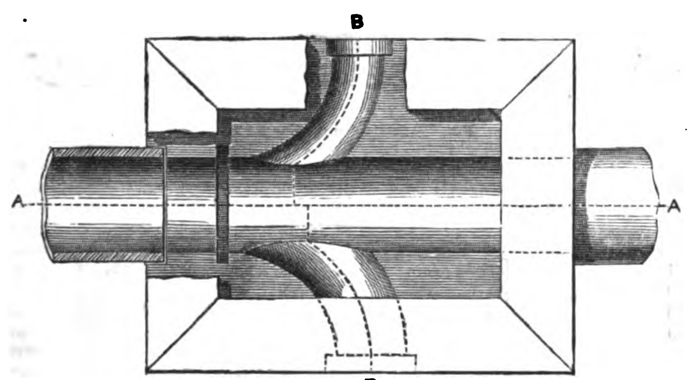



Fig. 2.—Plan of Bottom.

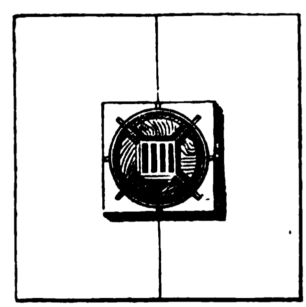


Fig. 4.—Plan of top of Lamphole, showing the Cover.

to a pumping-engine had been broken from being laid in bad ground, but after being relaid in wooden troughs no further fractures ensued. He was aware that the system of pipe sewerage had been, and must be, modified in practice to adapt it to certain localities; that in a rocky uneven bed improperly loaded pipes would break, and if of large dimensions, they were very liable to split longitudinally or be fractured transversely, as it was very difficult to get them accurately made and burned, and the false bearing at the sockets caused breakage. If in the case of Hitchin the rule laid down in Mr. Roe's tables had been followed, the outlet must have been 5 feet diameter, instead of 20 inches diameter.

No attempt has been made to divert the natural flow of the surface water, the street gullies being connected directly with the pipe sewers. In this, as in the arrangement for all towns, an engineer must modify his practice to meet local circumstances. He was satisfied with the general results at Hitchin; and as the earthenware pipes supplied by Messrs. Doulton, and put together with clay joints both of the full and half socket forms, had supported an internal pressure of a head of 4 feet, there was not much reason to find fault.

Pipe sewers had been in use at Manchester for seven or eight years, and Mr. Francis had expressed his satisfaction with the result; the only difficulties had arisen from a few cases of the choking of some of the smaller-sized pipes. In that instance where a great extent of oval pipe drains 25 inches by 18 inches had been laid with success, it should be explained that they were 2¼ to 3 inches in thickness, and were laid with great care in strong ground. The maximum size at which even these thick pipes were preferable to brick sewers was 30 inches by 24 inches. The smallest size made for small streets was 12 inches by 9 inches, and for foul water 6 inches by 4 inches. The largest area draining into a pipe sewer was about fifty acres.

On the authority of Mr. Harper, and quoting from a communication relative to some houses in Back King-street, Bury, he stated that though they had formerly been in so bad a state as to be untenantable, in consequence of fever constantly raging there, they had been rendered perfectly habitable by being drained with earthenware pipes, and that the experiment had been quite successful as regarded the general amelioration of the district.

[We next month intend giving an abstract of the discussion which took place at the Institution upon the subject of the above Paper. At present, however, we append some remarks made by Mr. Rawlinson towards the conclusion of the discussion, upon the subject of man-holes and lamp-holes.]

Man-holes and lamp-holes at short intervals, he said, were requisite on lines of pipe sewers, and each intermediate length should be quite straight, in order that they might be examined and cleansed, if and whenever it should become needful. At each manhole there should be an arrangement for flushing; and, in some instances, a depth of seven inches of deposit had been flushed out of a pipe of 15 inches diameter,

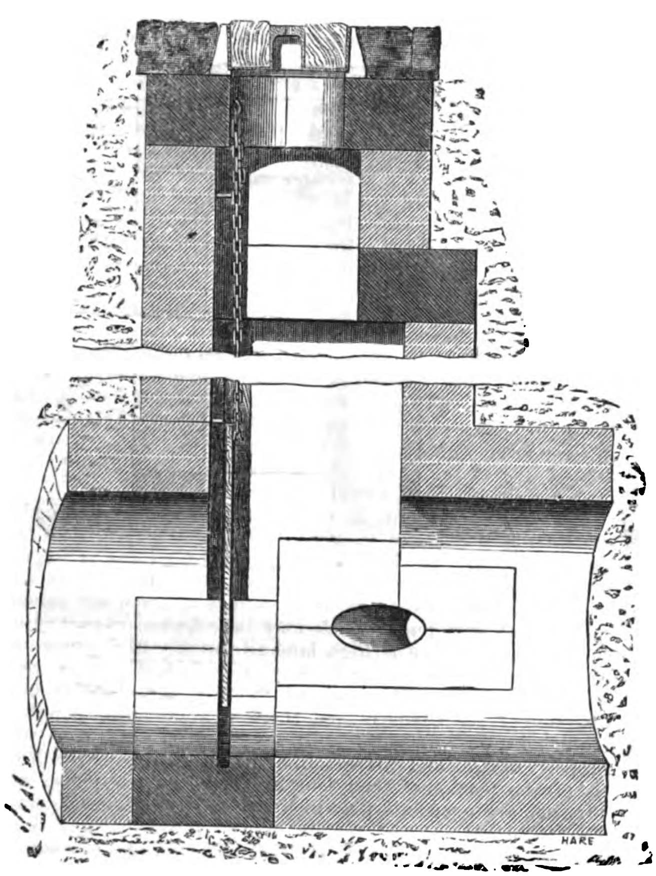



FIG. 5.—Manhole and Flushing Chamber, with Junctions on Brick Sewer. Section on the line A A, of Plan, Fig. 6.

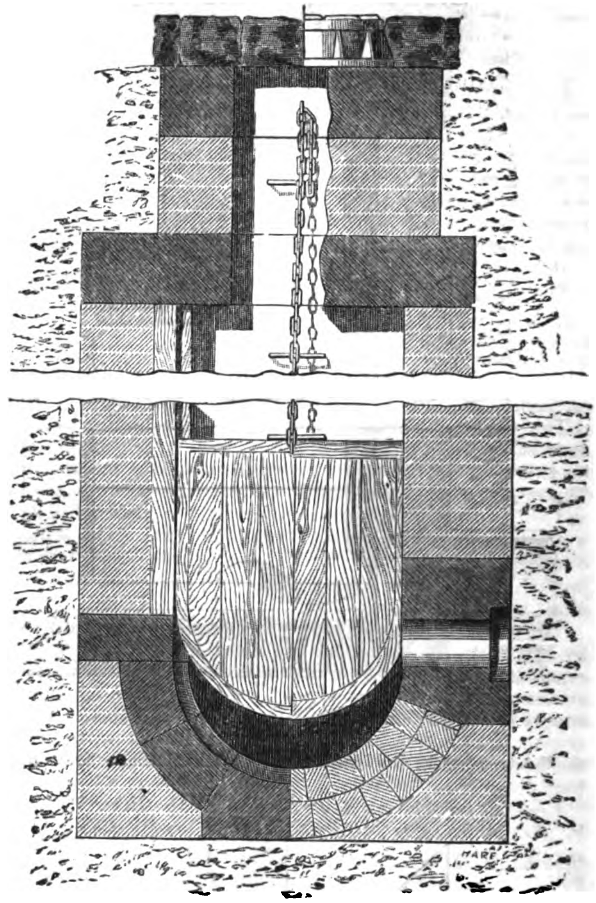



FIG. 7.—Section on the line B b B of Plan, Fig. 6.

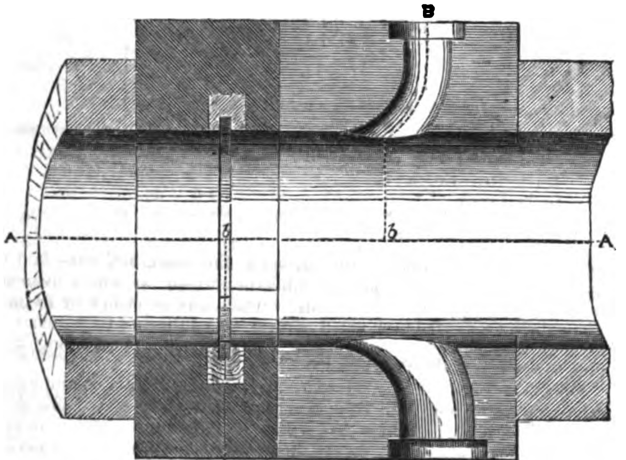



FIG. 6.—Plan of Invert.

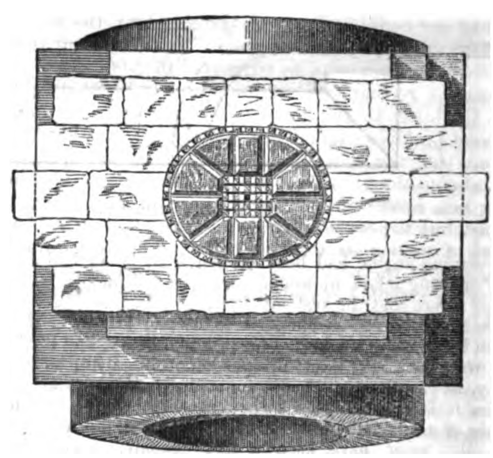


Fig. 8.—Plan of top of Man-hole, showing the Cover.

in ten minutes, leaving the pipe-drain perfectly clean. Precautions also were necessary to prevent sand, mud, or rubbish being introduced into the pipes whilst they were being laid; and the surfaces of roads, streets, and yards should be kept well cleansed, in order to prevent the dirt from being washed by heavy storms into and being deposited in the pipe sewers.

The annexed engravings exhibit the details of a manhole in a brick sewer, with side junctions from pipe-drains; and with a loose flushing-board fitting into a groove sunk in masonry. The manhole-cover could be lifted off by means of a key, in order that the sewers might be examined. Step-irons were fixed in all the manholes. All side junctions of pipe-sewers or drains, with brick sewers, were made with stone. Junctions were also now made of earthenware, and were preferable. The lamphole-cover was removable, so that a lamp or light might be lowered opposite the end of the sewer, in order to discover any stoppage.

## WATER SUPPLY AND SEWERAGE OF SWANSEA.

By Robert Rawlinson, C.E.

*First Report to the Swansea Local Board of Health.*

In accordance with a request contained in a letter from your clerk, Mr. Edward Strick, dated 20th April, 1854, that I would meet the Board in Swansea, on Thursday, the 25th April, I left London for that purpose, and at an interview with the committee, it was arranged that I should examine the water supply and sewerage, for the purpose of reporting thereon at the earliest possible period. A copy of Mr. Scott's report was placed in my hands, and I carefully examined the general and detailed survey of the town.

The committee are aware it was their wish that I would report, first upon the water supply, and especially as to the best means of making the existing works available to the uttermost. For this purpose, I made an inspection of the reservoir from which water is now drawn to supply the lower part of the town; as, also, a new upper reservoir not yet completed.

The existing works do not supply the higher parts of the district, neither can they, in my opinion, ever be made available for this purpose; they may, however, admit of some improvement. The area of land above the old and new reservoir is too limited, and the springs and streams too small, to yield a full supply of water for a large and rapidly increasing town. The water is also comparatively hard; and, as stored in open reservoirs, must be impure. At the time of my visit there were numerous tadpoles; at all times there will be conferva and animalculæ.

The question of water supply has been tolerably fully discussed by Mr. Scott, in his report of 1852. I have looked over that report, but consider it quite unnecessary to repeat published evidence, to prove that the existing works are not such as will supply the inhabitants of Swansea with good water in abundance, or even in moderate quantity. The works are now the property of the Local Board, and the only course to adopt is to make the best possible use of them.

I cannot recommend any extension of the Bryn Mill reservoir. It should however be kept in order,—well cleansed, and the spring supplying it opened out, to prevent waste which now takes place. The water from these springs may, with considerable advantage, be conveyed to the reservoir through earthenware pipes, properly laid, jointed, and covered. A considerable addition may be made to the present supply, if all the water at command is collected, as suggested.

The new reservoir may be finished, and the pipes now on the ground may be laid to convey water into the town; but before making any connnection with the old plant, the state of the pipes and taps ought to be ascertained. This reservoir may ultimately be used for new works, as suggested in this report.

I cannot recommend engine power to be used for lifting water from the lower to the new higher reservoir, as there should be the least possible expenditure on the present works; for I am of opinion that the water question, in Swansea, requires to be taken up and considered, in one respect, as though nothing had been done; not, however, for the purpose of neglecting the existing supply, but to prevent further mistakes, and an imprudent expenditure of money on works which are not as comprehensive and expansive as the requirements of the town demand.

Having satisfied myself that the district wherein the existing works are situated, will not yield the quantity of water at present required (and which will unquestionably be required), in Swansea, even should pumping be resorted to, I inquired if there were not other sources, at moderate distances; and several were named. I was informed that an Act of Parliament had been obtained to take water from Cwmgelly; as also that the river Llan had been proposed, and other minor streams in the district. Mr. Strick and Mr. Glasbrook also named the river Clydach. On the 26th and 27th of April I went, in company with the mayor, Mr. Strick, and Mr. Glasbrook, and examined Cwmgelly, the river Llan, several smaller streams near Swansea, and the river Clydach. Samples of the waters were obtained, and were subsequently submitted to Dr. Robert Angus Smith, of Manchester, for analysis, the results of which will be found in this report. As it will be necessary to obtain full information on the subject before any new works can be commenced, and as to obtain such information will be a work requiring much time, the expense may (at this stage) be avoided. It will be sufficient for the purpose of this report if I confine my remarks more to generalities than detail.

The present works I consider cannot be relied upon for the supply of water to Swansea. The reservoir is at an elevation too low, and the volume of water too small. Engine power would raise the water to a sufficient elevation, but I do not consider there is area or water at command, to warrant such an outlay; or, indeed, any costly permanent extension.

The several springs and streams from Cwmgelly to Swansea I also consider too limited, and otherwise objectionable. The Cwmgelly site, in my opinion, must be abandoned. During my visit, not more than ten thousand gallons of water per day was flowing down the valley. It would be most expensive, and I also consider, in some degree dangerous, to make storage reservoirs so near to the town. The water in such reservoirs would at all times be vapid, and more or less tainted, especially during very dry weather.

The river Llan would yield a sufficient volume of water even in dry weather, but the whole supply from this source would have to be pumped and forced through several miles of main. This river flows through ornamental grounds and fish-ponds of J. D. Llewelyn, Esq., and I am informed there is a mill or mills below the point from which the supply would be taken. Compensation, in some form, would have to be given for this water, besides the annual cost of pumping, which, from the length of main and height of lift required, would be most expensive.

The river Clydach is, in my opinion, the source to which the inhabitants of Swansea should direct their attention for a future supply of water to the town. The drainage area is large, the water abundant and singularly pure, the valley is but thinly populated, and almost free from minerals; there are numerous springs also very pure, which may be collected at any required elevation, and there is high land all the way to Swansea, along which conduit pipes of earthenware may be laid up to a covered service reservoir. The town of Swansea is extending in the direction of the Clydach, and there is a numerous population, requiring water, up to the junction of the rivers. Any works, properly devised and carried out, may be made productive through the greater portion of their length. There is mill power on the Clydach, arrangements for which will require due consideration. The following are the results of Dr. Robert Angus Smith's analyses of the waters of the district. The samples of water were taken on the 26th, 27th, and 28th of April, 1854, after ten or twelve weeks' dry weather. Mr. W. Roberts, and Mr. Strick (who owns and works the coal on the valley of the Clydach), stated they did not remember ever having seen the water so low:—

| | | | |
|---|---|---|---|
| River Clydach | 2·9 | degrees | of hardness. |
| Spring in the valley of the Clydach | 1·9 | do. | do. |
| Do. do. do. | 3·0 | do. | do. |
| | 7·8 | | |

or an average of 2·6 degrees of hardness.

| | | | |
|---|---|---|---|
| River Llan | 4·4 | degrees | of hardness. |
| Glanbrane Brook | 2·1 | do. | do. |
| Birchgrove Brook | 2·1 | do. | do. |
| Gelly Brook | 2·6 | do. | do. |

The river Llan, being the hardest water, contained most sulphate of lime. The total quantity was found to be 7·1 grains per gallon. All these waters are excellent—(the samples were remarkably clear). They are all soft, and contain chiefly sulphate of lime, a minute quantity of magnesia, and a little common salt. The water marked Glanbrane was least palatable.

The following table gives the quantitative analysis of the Clydach waters:—

| | Grains in a gallon. |
|---|---|
| Sulphate of lime | 1·6045 |
| Carbonate of magnesia | ·1542 |
| Sulphate of potash | ·0613 |
| Sulphate of soda | ·3113 |
| Chloride of sodium | ·75 |
| Silica | ·12 |
| | 3·0013 |
| Organic matter | 1·4 |
| | 4·4013 |

This water was tried with lead, and was found not to act perceptibly upon it; but a much harder sample in the same time gave a distinct amount of lead to the water. I thought it right to look for metals in the Clydach waters, but the tests did not give a trace.

(Signed) R. Angus Smith.

On comparing these analyses with those made by Professor Brande, and given by Mr. Scott in his report, it will be seen that the Clydach water is the purest in the district.

*General Remarks.*—Estimating the population of Swansea at thirty thousand, to provide twenty gallons per head will require six hundred thousand gallons of water per day. Any increase in the population, if provided for on this scale, will require, of course, a proportionate addition in the daily quantity to be supplied.

In establishing works of water supply, it is of primary importance to obtain the best source. The water should be the purest to be found in the district. The area from which it is to be drawn should be large, and free from works the tendency of which would be to taint the supply. If there are springs, they should be collected at the respective sources, and be conducted by means of earthenware pipes into covered fountain reservoirs. That source is the best which not only enables an engineer to secure such conditions, but which will enable him to supply the quantity required, or likely to be required, at such an elevation as will give high pressure without pumping, and volume without flood-water storing. Any moderate cost of additional distance in length of aqueduct main may safely be incurred to secure works which will yield such a supply.

The Clydach district is the only place within reach of Swansea where the advantages enumerated can be secured. The minimum volume of water in the river is several millions of gallons per day. The district, as is proved by the analysis of the water, is free from mineral impurities; the land, from its slope, mountain character, and isolation, is not likely to be more highly cultivated or more densely inhabited, and there is an elevation sufficient to give any required level above the town, with high land the whole distance, round which a comparatively cheap earthenware pipe conduit may be laid to service reservoirs above the town. Another advantage, and the greatest, consists in the district abounding with springs of singular purity, most of which are at elevations to render their waters available. Fully one-half the water required by the town may be, as it were, created; that is by collecting the springs, and by preventing evaporation and waste, water will be obtained which at present is lost on the mountain side, never reaching the river or the mills.

It is evidently one of the plainest maxims of prudence to select such a source, and such water for the supply of a town, in respect of quantity and quality, that no removal or alteration is likely to be subsequently required. When a wrong choice is made, every after expense, in extending such works, is but an aggravation of the first error.

The advantages of a supply of soft water are numerous; for instance, in the saving of soap, in the saving of tea, in the saving of clothes, in preventing furring or deposit in steam boilers, &c. One degree of hardness represents 2½ ounces of soap to be wasted with each one hundred gallons of water used for washing. Thus, one hundred thousand gallons of water, of one degree of hardness, will require the use of about 132 lb. of soap, which at 6*d*. per lb. represents 3*l*. 6*s*.. The Clydach water has an average hardness of 2·6. If, therefore, any harder water be used, and fifty thousand gallons of water are consumed daily for washing purposes, the cost to the town will be 1*l*. 13*s*. per day for every degree of hardness above 2·6, or an annual cost of 602*l*. 5*s*. Five degrees in excess of 2·6, will therefore cost 3011*l*. 5*s*. per annum more than Clydach water, for soap alone.

*Proposed Works of Water Supply.*—Sketch of works necessary to render the waters of the Clydach available:—The springs should be collected at the respective sources, and be conducted through earthenware pipes into a fountain reservoir, which must be covered. The line of aqueduct main will contour the land as far as possible. Valleys or water-courses may be crossed by light aqueducts, continuing any given gradient; or cast-iron syphon pipes may be adopted. Small covered service reservoirs may be constructed at the most convenient points where a supply is required, for populations situate on the line of the main; and one or more service reservoirs will be required for the town, at such elevation as will command every house within the borough. From these service reservoirs the mains, sub-mains, and branches will proceed into the town, and conduct the water into each street and every house, preserving it pure and cool, as collected from the springs.

*Proposed Works of Sewerage.*—During my short stay at Swansea, I could not enter into details necessary for a full report on the sewerage of the town. I examined the present outlet, as also the general features of the place; and, with the exception of that portion within tidal influence, I can say there will not be any work to execute either peculiar, difficult, or costly. Brick outlet sewers will be required in the low and level parts of the town; but in the higher parts, and along streets of steeper gradients, earthenware pipes may be adopted with advantage and economy.

*Summary.*

Having examined the existing waterworks, and having further considered the question of water supply, for the present and future requirements, I arrive at the following conclusions:—

That the existing works cannot be relied on for a full supply of water to Swansea.

That the water is comparatively hard, and is at present impure.

That the most economical expedients should be immediately resorted to, in order to make the present works available to the fullest extent.

That a full supply of pure and soft water will be of the greatest benefit to the inhabitants of Swansea, and the adjoining district, for domestic and other purposes.

That the water of the river Llan must be pumped, and the waters of Glanbrane, Birchgrove, and Gelly brooks must be stored, if used; all of which I consider objectionable.

That the river Clydach, and the springs having their source in the valley of the Clydach, yield pure waters in great abundance, sufficient not only for the present wants of the inhabitants of Swansea, but sufficient for any future requirements of the borough and surrounding district.

That accurate information is required relative to the existing works, the state of the mains, house service pipes, fittings, &c.

That the present reservoir should be preserved clean, the springs opened out, and the water prevented from wasting, either by absorption or evaporation.

That the new reservoir be completed, the pipes on the ground laid, and that the water available be put to its fullest use.

That accurate sections of the streets, &c., are required, to enable an engineer to devise and lay down a proper and comprehensive system of sewers and drains.

That surveys, sections, and gaugings, are required to enable an engineer to report fully on the proposed source of water supply, and to prepare estimates.

I beg therefore to recommend that the Board authorise the employment of a surveyor to put the present works to their full use, to complete the new reservoir, &c., and to make such surveys and sections, and obtain such general information, as will enable me to report fully, and to furnish the Board with detailed estimates for the necessary works of sewerage and water supply.

APPENDIX.

The following I submit as approximate estimates for works of water supply and sewerage:—

*Water Supply.*—The distance from the Clydach to Swansea is about seven miles; that is, an aqueduct main winding round or contouring the high land will be about seven miles in length. An earthenware pipe may be laid complete, capable of conveying one and a half million gallons of water in 24 hours, at a cost not exceeding 10*s*. per lineal yard. This would make the cost of such a main about 6000*l*. The necessary works on the Clydach for collecting springs, &c., need not cost more than 4000*l*., making in the whole, for collecting the water and conveying it to Swansea, 10,000*l*.

Service reservoirs, service mains, sub-mains, and branches, within the town, will not cost more than 15*s*. per head, making, for a population of 30,000, a sum of 22,500*l*. Add for land, compensation, engineering, incidental expenses, and other contingencies, 10,000*l*., and the estimate will be as under:—

| | | | |
|---|---|---|---|
| Works on the Clydach ..................... | £4,000 | 0 | 0 |
| Aqueduct main to Swansea ............... | 6,000 | 0 | 0 |
| Plant within the town, service reservoirs, pipes, &c. .......................... | 22,500 | 0 | 0 |
| Compensation, land, engineering, and incidental expenses and contingencies | 10,000 | 0 | 0 |
| Total ..................... | £42,400 | 0 | 0 |

I find Mr. Scott estimates the cost of waterworks, (for an increased population of 55,000) as under:—

| | | | |
|---|---|---|---|
| Works on the Western district............ | £91,000 | 0 | 0 |
| Works on the Cwmgelly district ......... | 55,000 | 0 | 0 |

The works, as projected for the Clydach district, will serve for a population of 100,000, and may, at any time, be increased to serve a population of half a million, without the loss of one pound of the money expended on the projected works.

*Sewerage.*—The sewerage of Swansea I have said will not be difficult. There are peculiarities to be considered,—in outlet, in contour, and in sub-soil. These will, in a degree, alter any general estimate, but not to an extent of 10 per cent. I have estimated in detail, works of sewerage, complete, for a similar population (30,000), and I consider that a sum of 25,000*l.* will most completely sewer and drain the borough of Swansea.

| *Springs Gauged in the Clydach Valley*— | | Gallons in 24 hours. |
|---|---|---|
| White well, Clydach | about | 45,000 |
| Cefn Parc spring | about | 40,000 |
| Ffynon Las spring | about | 35,000 |
| Two small springs | about | 40,000 |
| A third small spring | about | 10,000 |
| | or a total of | 170,000 |

These, as Mr. Strick and Mr. Glasbrook can verify, form only a small portion of the whole, and yet it will be perceived there is nearly one-third of the 600,000 gallons required for present purposes.

*June 5th*, 1854. Robert Rawlinson, C.E.

*Second Report to the Swansea Local Board of Health.*

On the 5th June last, I reported briefly on the water supply and sewerage of Swansea. Since that period, one of my assistants has thoroughly investigated the existing "plant," and I now beg to suggest such alterations, and additional works, as appears best calculated to make the existing water supply available to the uttermost.

*Waterworks.—Suggested Extension and Improvements.*—The waterworks at present consist of an open reservoir at Bryn Mill, from which a cast-iron main leads to the town of Swansea, and there are branch pipes through certain streets in the lower part of the town. All the springs flowing into the reservoir pass through open channels, and consequently the water is liable to contamination, from disturbance by cattle, and otherwise; as also during heavy rain. It is proposed to lay earthenware conduits from the springs down to the reservoir, so as to preserve the water comparatively pure at all times. Some of the springs now flowing down to the Bryn Mill reservoir may be taken to the Cwmdonkin reservoir, giving all the additional pressure obtained from the latter site.

The service pipes within the town have been examined. They are sound, but deposit and rust have diminished the water way, by partially choking them. A portion of this deposit may be cleared out, and the pressure from the Cwmdonkin reservoir will render the pipes more serviceable, by quickening the flow. The street mains will, I believe, bear the additional pressure. House service cocks, of the common low-pressure construction, must be replaced by high-pressure screw-down taps. This need not cost more than from two to five shillings per house, including material and labour.

*Cwmdonkin Reservoir.*—It is proposed to make this reservoir water-tight. At present, with 37,000 gallons of water per day flowing in, not less than 19,000 or 20,000 gallons are lost by leakage, with an average depth of four feet. The depth, when full, will be about 18 ft. 6 in.

It is also proposed to conduct the waters from Fynone and Carn Glas springs into Cwmdonkin reservoir; thereby adding to the volume of water which may be delivered at high-pressure.

A portion of the 12-inch pipes will be laid from the reservoir, and all the 7-inch pipes at present in store (with such additional length of new pipe as may be required), will be laid along the new road, to Mansel-street and Cradock-street. This main will also supply Brunswick-street and Brunswick-place.

The new mains will be connected with a portion of the old mains, giving additional pressure, and consequently making them more efficient.

All existing street valves on the water mains require casings to protect them.

New fire cocks or hydrants are required. These, with the water from Cwmdonkin reservoir, will do the work of many fire engines. Streets may also be watered, and channels cleansed, by means of the hose and jet.

The water in Cwmdonkin reservoir will be 206 feet above datum, or medium tide level. This will give about 100 lb. pressure on the inch at the docks and wharves. If hydraulic cranes and lifts are used, they may be worked by this pressure.

The works, as proposed, will bring in an immediate rental far more than equivalent to the outlay.

The whole of the works proposed below the Cwmdonkin reservoir, new mains, repairs to old mains, valves, and hydrants, will be serviceable should the Clydach scheme be accomplished.

The entire expenditure now proposed for these works will be as under:—

| | | | |
|---|---|---|---|
| Cwmdonkin reservoir to be made water-tight, say... | £250 | 0 | 0 |
| Covering in Cwmdonkin stream | 60 | 0 | 0 |
| Diversion of Carnglas stream | 275 | 0 | 0 |
| Diversion of Fynone stream, &c. | 150 | 0 | 0 |
| Providing and laying new mains to town | 750 | 0 | 0 |
| Putting casings on old valves | 35 | 0 | 0 |
| New hydrants or fire cocks | 150 | 0 | 0 |
| Fixing ditto ditto | 50 | 0 | 0 |
| Stand-pipes and hose | 50 | 0 | 0 |
| Altering old mains, cleansing ditto. | 150 | 0 | 0 |
| New mains in side streets | 2000 | 0 | 0 |
| Contingencies | 90 | 0 | 0 |
| Total | £4000 | 0 | 0 |

This expenditure will furnish to the town about double the present volume of water supplied by the works as they now exist; and will ensure the water being free from surface contamination, both to the Cwmdonkin and Bryn Mill reservoirs.

The present minimum volume of water supplied by the old works is 120,000 gallons per day. The Cwmdonkin reservoir, completed as proposed, will supply an additional 120,000 gallons in the driest season.

*Sewerage.* — The whole question of Sewerage cannot be laid before you at present, as the requisite plans are not completed. Attention has however been directed to the east side of the river, as also to the Town Ditch and Mysydd Fields district. The works proposed to be executed in these districts, will form part of any general scheme. They may at once be carried out, giving immediate relief in places where fever prevails, and the new outlet sewer will be brought more fully into use. The particulars of the works proposed to be undertaken immediately, are as under :—

East side of river:—

1230 Lineal yards of main sewer.
15 Manholes and covers.
28 Street gullies.
1 Tidal cast-iron outlet, with flap, &c., complete
Estimated cost, £600

Town Ditch and Mysydd Fields district:—

2880 Lineal yards of main sewers.
30 Manholes and covers.
50 Street gullies.
Estimated cost, £2000

Summary:

| | | | |
|---|---|---|---|
| Waterworks | 4000 | 0 | 0 |
| Sewerage of Mysydd Fields district | 2000 | 0 | 0 |
| Sewerage east side of river | 600 | 0 | 0 |
| Total | £6600 | 0 | 0 |

It is proposed to expend 4000*l.* in improving the water-works; this, at 5 per cent., represents 200*l.* per annum: for depreciation, and to provide a sinking fund to repay the principal in thirty years, say 100*l.* additional. The annual charge will thus be 300*l.*, and the probable income may be stated as—

| | | | |
|---|---|---|---|
| 1500 Houses, at 10*s.* each per annum | 750 | 0 | 0 |
| Trade purposes | 150 | 0 | 0 |
| | £900 | 0 | 0 |
| Deduct Annual charge for interest and depreciation | 300 | 0 | 0 |
| Clear gain | £600 | 0 | 0 |

In addition to which the principal, or proposed outlay of 4000*l.*, will be paid off in thirty years.

The Board will be enabled to judge as to the benefit to be derived from the proposed expenditure on the waterworks. It will be bringing into use much property now absolutely waste; and the additional houses supplied will be benefitted far more than the rental proposed to be charged. The existing works are in a very neglected and ruinous condition. As stated, all the water collected is liable to surface and other contamination. The sluice valves within the town are absolutely without any casings, and the brass spindles, in some places, project through the roadway several inches, exposing the valves to ruinous concussions from cart wheels and endangering the feet of horses. There are no fire cocks on the mains which can be used; neither are there any wash-out valves. The cost of these improvements and additions is included in the estimate given.

ROBERT RAWLINSON, C.E.

*Westminster, Nov.* 4, 1854.

## NEW MANUFACTURE OF SHOT.

PROFESSOR WILSON, in his special Report on the New York Industrial Exhibition, describes the following new process for the manufacture of shot:—The building, of the height of an ordinary house, was arranged so that a cylinder or large shaft in iron or wood should connect the upper story where the melting-furnace and dropping-pan were fixed, with the lower story in which the water receiving-tub was placed. This cylinder or pipe constituted the air-shaft, and communicated at the bottom with a blower driven by steam power. When in operation, the metal was melted at the top in the usual way, and dropping down this shaft encountered a powerful blast of cold air being driven up it, the divided metal or shot finally falling into the water-receiver at the base. The advantages of this over the ordinary method of making shot, show themselves in two or three points. In the first place, the expense of building a high tower is avoided; the effect obtained by letting the molten lead fall through a long column of air in a quiescent state, is equally secured by its descent through a shorter column driven rapidly in an opposing direction. The saving in power required to lift the lead to the lesser height will go far towards furnishing the power required to drive the blast. In the practical part, he was informed a very decided advantage was shown over the ordinary method. In dropping lead from a high tower, it is necessary to keep the lead at as low a temperature as possible, consistent with its fluidity or capability of being poured, in order to counteract the tendency which the shot (the divided metal) has to burst while falling at a high velocity, owing to the unequal resistance of the air, and thus become useless except as metal.

In the old method a considerable proportion of waste shot is thus incurred, and in dropping large sizes, a greater or less proportion of smaller sizes are always made, and, indeed, a certain quantity falls of so small a size as to be fit only to be melted up again. By this new method, the metal is dropped at a higher temperature, its fluidity enables it to drop more rapidly, and the falling shot are cooled so rapidly and so equally by the blast, that no loss is sustained by bursting, and each dropping made varies but in a small proportion from the sizes worked for.

The process was invented in 1848, by David Smith, of the firm of T. O. Leroy and Co., of New York, who commenced the manufacture of shot in 1849, and have carried it on successfully up to the present time, having made and sold upwards of 5000 tons in that period. The process is patented in the United States, and also in this country.

## IMPROVED STEAM TRAVELLING-CRANE.*

(*With an Engraving, Plate* XLI.)

THE economy of manual labour in working travelling-cranes is a subject of great importance to the builder and contractor for heavy works, and much attention has been given to the subject for several years. Steam power has been employed for some time for the lifting and removal of heavy weights, and the amount of saving in wages effected by a steam travelling-crane, compared with the ordinary hand-labour machine, has been sufficiently proved during the last four years.

The crane which is the subject of this paper, the construction of Messrs. Dunn, Hattersley, and Co., of Manchester, closely resembles the general appearance of the ordinary travelling-crane used by masons and contractors, as shown in the Engraving, Plate XLI. The longitudinal way, transverse carriage, and crab, are arranged in the usual manner. The steam-engine and boiler with its driving-gear is supported upon a platform at one extremity of the transverse carriage, being fixed thereto and travelling with it, in a longitudinal direction, whenever so required.

The advantages sought by this crane are, that the steam power travels with the traversing carriage, and does not require any longitudinal shafts or bearings, which is the case when a fixed engine is employed; the lubrication and friction of the longitudinal shafting being also saved. It was found from the great length of the longitudinal travel in the remarkably extensive works for the viaducts and bridges of the Grand Trunk Railway of Canada, that the introduction of such modes of driving was too expensive. The saving of these shafts and bearings in the first cost was not the only consideration, the wear and tear, and lubrication being a further source of expense, and the repairs very inconvenient.

The steam travelling-crane was designed for the construction of the above works, for the contractors, Messrs. Peto, Brassey, and Betts. It was intended to work to a distance of three-quarters of a mile, by extending the framing and traversing rails. The first crane was completed, but not yet at work; it was intended for setting the stones of the piers in the Great St. Lawrence Bridge, and several more were being constructed. The cost of the whole was 550*l*., including the engine and boiler, but exclusive of the timber-work for the frame of the traveller and platform and the shed over the engine, which was not sent out, and would be supplied in Canada; and it is thought would not exceed a total cost of 650*l*. including them. The crane was intended for lifting 10 tons, and moving it into any position; it would take more, but was constructed to take that load in regular work. The engine and boiler weighed 2¾ tons; a pair of cylinders, with cranks at right angles, was employed to give uniform motion without a fly-wheel, and the boiler was tubular, 2 ft. 4 in. diameter and 8 feet long, with 2-inch copper tubes; the fire-box casing was lined with fire-bricks, and had to be adapted for burning green wood, the fire-bricks retaining the heat for the fresh charge.

A pair of small direct-acting horizontal high-pressure steam-engines A, A, are secured to the two main timbers B, B, of the traversing-carriage. The boiler C, is constructed for burning wood; the tubes are made of solid copper, without seam or joint, so that the acid from the wood cannot corrode them.

The engine and boiler with the driving-gear are protected from the weather by a cabin D, D, constructed of light framework, and covered with a corrugated iron roof. The power of the engine is transmitted by a spur-pinion E, upon the middle of the crank-shaft, through a spur-wheel placed on the horizontal main driving-shaft F, which communicates the motion for hoisting, lowering, traversing, and moving the crane longitudinally. Each motion can be used independently of either of the others, or simultaneously, when required. The communication of the power to the various motions is effected by the three sets of mitre-wheels upon the main-shaft, which are engaged or disengaged at pleasure by means of three handles G, H, I, that move the sliding clutch-boxes as required by the attendant. Three mitre-wheels are furnished to each motion, so that whilst the engine revolves continually in one direction, the reversing of any motion can be effected by the intermediate wheels, as in the ordinary manner.

The motion for moving the carriage longitudinally is conveyed through the wheels at I, at the extremity of the driving-shaft furthest from the boiler. The middle one of the three handles H, engages or disengages the motion K, for hoisting and lowering; and the handle G, next to the boiler belongs to the motion L, for traversing the crab with its weight. The arrangement for moving the crane longitudinally by means of spur-gearing driving the travelling-wheels T, T, is similar to the plan adopted to a hand travelling-crane. The travelling-wheels run upon rails M, M, which are fixed at 54 feet gauge, centre to centre.

The hoisting and lowering motion is transmitted to the chain-barrel K, of the crab, by means of an endless chain N, which is placed in the longitudinal direction of the traversing-carriage, and is driven by a pulley fixed upon the counter-shaft O, parallel to the main shaft; the motion is communicated by a pair of mitre-wheels through the short intermediate shaft at right angles. This endless chain is connected to a pair of mitre-

* Paper read before the Institution of Mechanical Engineers, Birmingham, by WILLIAM FAIRBAIRN, C.E., Manchester.

# STEAM TRAVELLING CRANE.

Fig. 1. *Side Elevation.*

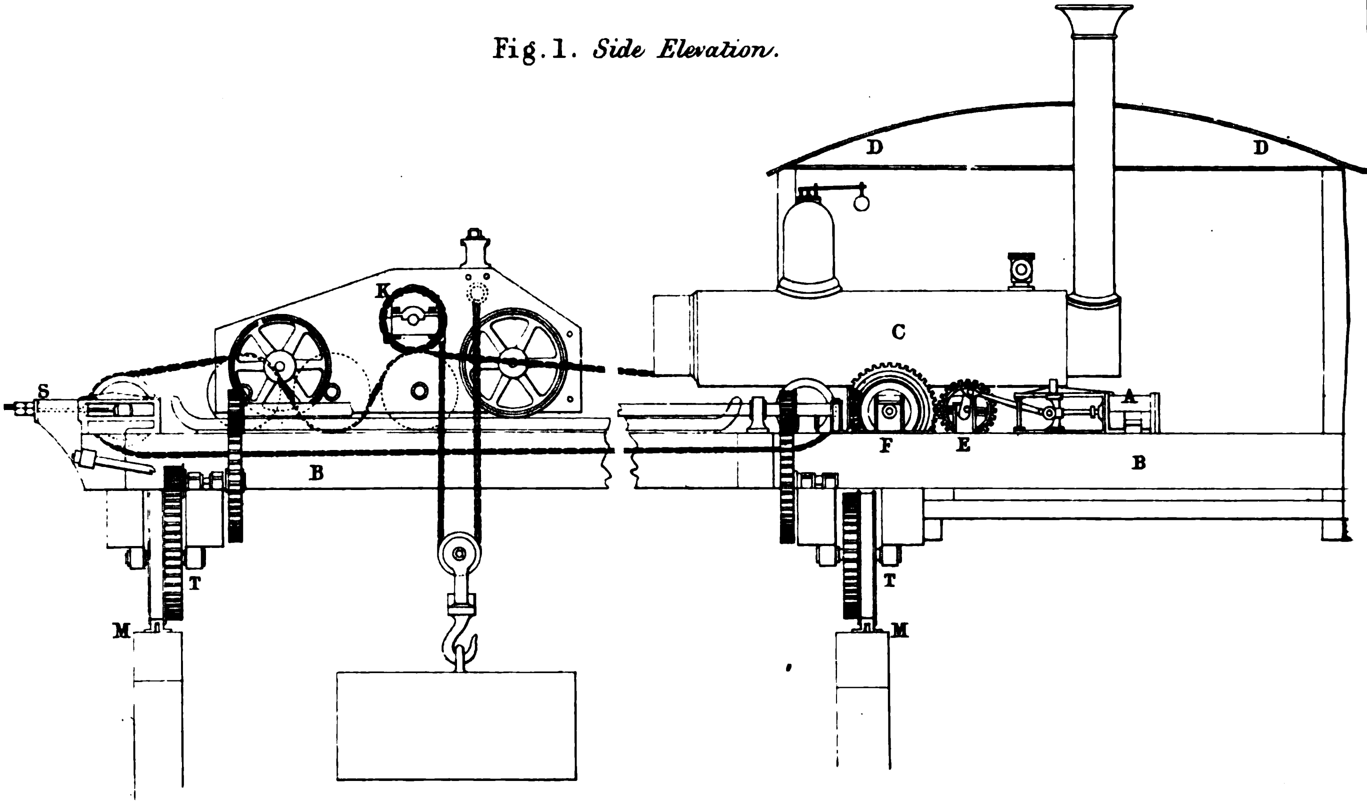
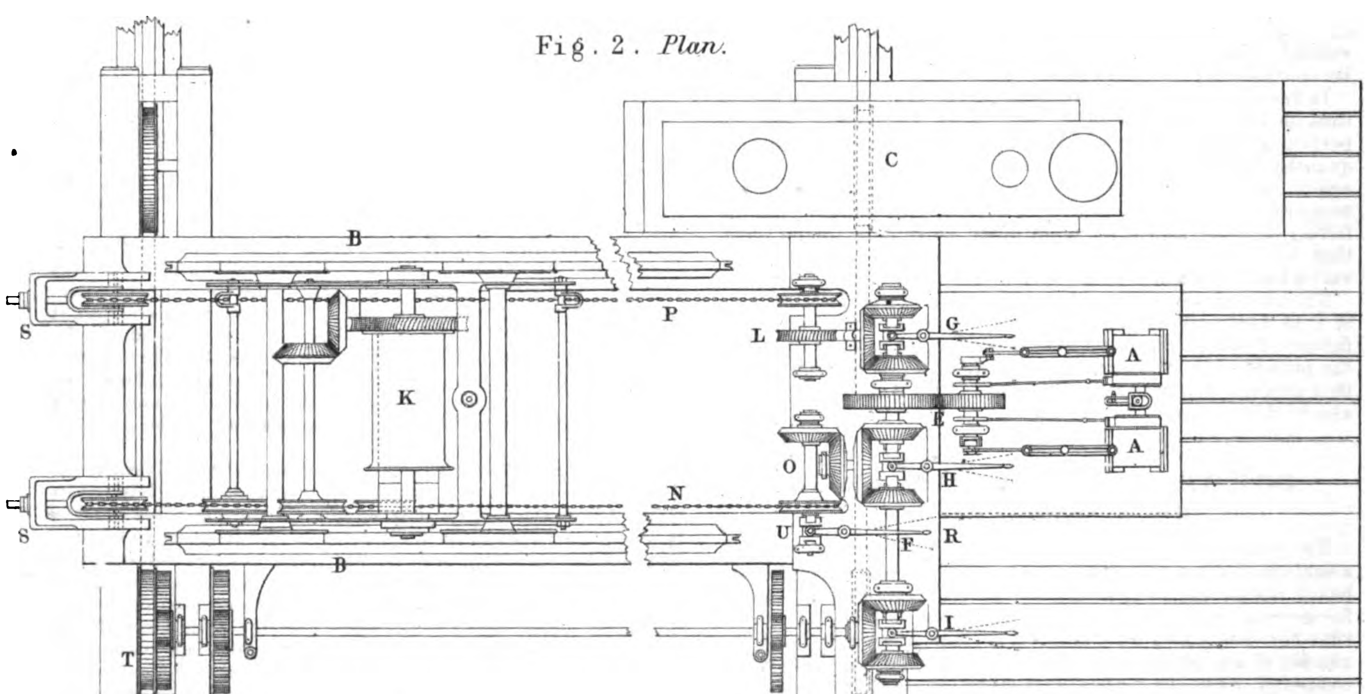



Fig. 2. *Plan.*




*Scale 1/48th* 0 1 2 3 4 5 6 7 8 9 10 *Feet*

J.R.Jobbins.

wheels fixed at the lower end of the crab-carriage, which give motion to a worm-wheel, the latter being keyed upon the chain-barrel.

The transverse motion of the crab is obtained by another chain P, placed in a parallel position on the opposite side of the main timbers of the traverser-carriage; this chain is attached to the four-wheeled crab, and passes over a pulley on the axis of the worm-wheel L, which is driven by the bevil-gear.

An additional handle R, is provided for the purpose of throwing out of gear the chain N, of the hoisting motion, by means of the clutch-box U, at the time of the transverse motion of the crab; and the chain N, then runs with the crab; the pulley at U, turning loose on the shaft.

A simple apparatus for adjusting the requisite tension of these chains is provided at the furthest extremity of the two main timbers of the traversing-carriage, at the opposite end to the engine, consisting of a tightening-pulley S S, sliding in grooves, and drawn back by a screw.

This crane is constructed to lift at the rate of 6 feet per minute. The longitudinal motion works at the rate of 30 feet per minute, and the transverse motion at the rate of 20 feet per minute. The engines are 6-horse power collectively. A wrought-iron water-tank is placed under the engine, the top-plate of which formed the bed-plate for fixing the cylinders.

The motions can be worked altogether or separately, as desired; and the clutch-box levers are so arranged that the man in attendance can work all the motions from one place.

## WATER SUPPLY OF BIRMINGHAM.

*Report of* THOMAS CLARK, C.E., *to the Public Works' Committee.*

HAVING on the 5th of August last been favoured with a copy of a resolution passed by your Board, directing Mr. Pigott Smith to call in my aid, to ascertain the quantity of water that could be collected at Digbeth, and made available to supply the town of Birmingham, with an estimate of the probable costs; after conferring with Mr. P. Smith on the subject, and making a general survey of the suburbs of the town, I found that to have anything like an adequate supply, the quantity to be obtained must be a very large one indeed. A careful consideration of the requirements of the place, induced me to write to you on the 16th of the same month, soliciting you to favour me with your estimate of the probable quantity of water you deemed it necessary to obtain. This led to my being favoured with an interview with the committee, when the subject of the supply was brought fully under the attention of the committee, and I was directed to examine the locality, and report to you what supply, in my opinion, it would be practicable to obtain—how it could be obtained and made available—and the probable cost of the same.

I beg leave now to submit to you my report, accompanied with drawings, illustrative of the mode of constructing the works which I shall recommend to your consideration, for effectuating the object you have in view, as to procuring the supply, raising it, and distributing the same.

As regards the place where the supply should be procured, it appears to me that the best that could be selected would be the piece of vacant ground in Park-street, partly belonging, as I am informed, to the corporation, and partly to Mr. Dadley.

The situation of the ground, renders it, as it appears to me, the most fit place for the waterworks. I, therefore, made an experiment to ascertain the nature of the strata, and the probability of obtaining a good supply. The experiment was made by boring down to the depth of 137 feet, which proved so successful as fully to justify the selection of the place. This experimental boring, or testing the supply, yielded a flow of water at the rate of 115,200 gallons of water per day of twenty-four hours, and of a quality most unexceptionable, as the chemical analysation to which it has been submitted, and to which I shall hereafter have occasion to allude, will clearly show.

The survey I have made, together with the results of the experimental boring, satisfy me that a supply of excellent water, to the extent of 1,008,000 gallons of water per day of twenty-four hours, or 700 gallons per minute, may be relied upon.

I recommend the following plan to be pursued, for the purpose of obtaining a supply, and to make it available for the town.

That four shafts each 8 feet clear in diameter, should be sunk; that a communication by tunnelling, or adits, constructed of an oval shape, should be made from the others to the shaft, which on the plan No. 2, is represented as the pumping shaft. That the depth of the pumping shaft should be 90 feet, and 10 feet diameter. All the shafts to be steined with 14 inches brickwork laid in Roman cement, and that a boring of 15 inches diameter should be made in each of the shafts, to the depth of 140 feet from the surface of the ground, and in all the borings to fix a cast-iron pipe of 12 feet in length, and securely drive the same 8 feet below the bottom of the respective shafts, as shown on the section accompanying this. That all the tops of the shafts should be covered with wrought-iron chequered plates, fixed to strong iron girders, at the surface of the ground, to afford free access at any time to the shafts. If you should be pleased to adopt this mode, I feel no doubt whatever but that the supply I have mentioned, viz., 1,008,000 gallons of water per diem of twenty-four hours will be obtained.

To raise the supply, I advise that a double set of three-throw pumps should be fixed in the pumping shaft; the pumps to be 16 inches in diameter, and have 2 ft. 6 in. stroke. The barrels and fittings to be gun-metal, and the buckets to be fitted with butterfly valves, and the lower boxes also. The suction pipe to be cast-iron, 12 inches in diameter, and faced; above the barrels a false main cast-iron pipe, 17 inches in diameter, to be carried up the shaft above the surface-line of the water. This false main pipe to be fitted with flanges and faced. The joints to be connected by wrought-iron bolts and nuts. Cast-iron bonnets, with proper stuffing-boxes faced with gun-metal, with a copper piston-rod to work through each. The whole of the pump work to be supported by strong cast-iron girders, and wrought-iron tie-rods The pump-rods to be $1\frac{3}{4}$ inches in diameter, and the joints secured by proper couplings and strong bolts. Should a tank as subsequently mentioned, be erected, then a 12-inch cast-iron main pipe, to be carried to the tank, and an air vessel fixed to the same.

And that the pumps should be worked by a steam-engine of 45 horse power. To have a spare boiler; each boiler to be 53-horse power, with two safety-valves to each, all to be of the best manufacture.

I beg also to recommend that a tank should be erected, as shown on one of the drawings accompanying this. The tank to be 120 feet long, 60 feet wide, and 5 feet deep. To be constructed of cast-iron plates, $\frac{7}{8}$-inch thick, upon strong cast-iron girders, to be fixed on brickwork. The top of the tank to be covered over with a light iron roof glazed.

In speaking of the height of the tank, I must beg the favour of your attention to a map of the town of Birmingham, upon which drawing there are several parts, designated by particular colours. In order to distribute a supply of water over the parts of the town indicated on the drawing by the colour green, it is necessary that the water should be raised to the height of 25 feet. To distribute it over the part coloured pink, that it be raised to the height of 35 feet; and to distribute it over the part coloured blue, that it be raised to the height of 45 feet.

Entertaining the fullest confidence that the quantity of water I have stated could be obtained, I felt the importance of being able to satisfy you as to the quality of that from the experimental boring. I therefore carefully took samples of water from the experimental boring at Digbeth, from the waterworks main pipe, and from Park-street pump, and took them myself to Mr. Professor Brande, of her Majesty's Royal Mint. The following is a copy of his report upon the analysis, which I have much pleasure in adding.

*Copy of Mr. Brande's Report.*

I have carried the examination of three samples of water from Birmingham, sent to me by your order for analysis, as far as time has allowed, and herewith send you such particulars respecting them, as will, I trust, be sufficient for your present purpose.

There is nothing objectionable in the *physical characters* of these waters. They are *bright, colourless, tasteless*, and well aërated, but they all of them come under the denomination of *hard waters*, and the sample from the Park-street well is so hard as to be quite unfit for any purposes in *which* soap is used.

The total solid contents, in *one imperial gallon*, of each of the waters, were determined by careful evaporation, and perfectly drying the saline residue at a temperature of 212°. The following are the results.

I. WATER FROM THE EXPERIMENTAL BORING.—The imperial gallon leaves 34 grains of solid matter, or 1 in 2058. The *hardness* of this water, as indicated by the soap test, is from 16° to 17°; pure distilled water being the standard of *unity*.

II. Water from the Birmingham Waterworks.—The imperial gallon leaves 37·2 grains of solid matter, or 1 in 1881. The *hardness* of this water is between 24° and 25°.

III. Water from the Park-street pump.—The imperial gallon of this water leaves 159·5 grains of solid matter, or 1 part in 438. With these very impure waters, the indications of the soap test becomes somewhat equivocal, but the *hardness* of this sample may be placed somewhere between 90° and 100°.

The substances which are contained in these waters are soda and lime (with traces of magnesia, potassa, silica, oxide of iron, and a very slight indication of organic matter), together with chlorine, carbonic acid, sulphuric acid, and nitric acid.

The salts derived from the above constituents appear to exist in the respective waters as follows:

| | |
|---|---|
| Chloride of sodium,<br>Sulphate of soda,<br>Sulphate of lime,<br>Nitrate of lime,<br>Carbonate of lime,<br>Traces of magnesia,<br>Traces of potassa,<br>Traces of oxide of iron,<br>Traces of silica,<br>Traces of organic matter,<br>Traces of phosphoric acid, | 34 grains in the water of the Boring, equal to 1 in 2058.<br>37·2 grains in the Waterworks, equal to 1 in 1881.<br>159·5 grains in the Park-street pump, equal to 1 in 438. |

The quantity of *chloride of sodium* (common salt), contained in a gallon of water of the experimental boring, is 7·60 grains; in that of the Birmingham waterworks, 4·26 grains; and in water from the Park-street pump, 31·36. The quantity of *sulphate of lime* in the same water is, for the boring, 8·82 grains; for the waterworks, 2·08 grains; and for the Park-street well, 46·48 grains; in this latter water also, the proportion of *nitrate of lime* is very large; the same salt is contained, though in much smaller relative proportion, in both of the other samples. It is therefore evident, that although each of these waters appear to contain the same saline substances, their relative proportions to each other are very different.

William Thomas Brande.

*Royal Mint, November* 13, 1852.

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I have now to solicit the favour of your consideration to this report, with the drawings and plans illustrative of the same. I do so in the hope that I have executed the directions you were pleased to give me, in a manner that will be satisfactory to you, and that should any of the recommendations I have humbly submitted to you be adopted that I shall be further favoured by your orders to execute the same. Permit me to add, that should the works be entrusted to me, no effort shall be wanting on my part to secure your satisfaction.

I estimate the cost of executing the whole of the works, every part thereof to be done in the best manner possible, and all materials used to be of the best quality of their respective kinds, will amount to the sum of about 27,500*l.* Say twenty-seven thousand five hundred pounds.

Thomas Clark.

4, *Furnival's Inn, Holborn, Nov.* 15, 1852.

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Report of Robert Rawlinson, C.E. F.G.S., and J. Pigott Smith, Assoc. Inst., C.E.

*To the Chairman of the General Purposes' Committee.*

In accordance with instructions contained in a resolution of your committee, we have examined most carefully and fully into the question submitted to us. The question of "water supply" for so great and important a town as Birmingham is of the utmost importance, and demands all the attention which can be given to it. Few places are so fortunately situated as to have a full supply of water at command, so unexceptionable and so advantageously situated, as to leave no room for dispute as to which is the best mode of supply. Birmingham is not so situate. It therefore becomes necessary to consider the several features of the case, as they may be presented to the committee. There may be three forms of supplying a town with water, or there may be a combination of these.

1. Water may be pumped from wells, sunk into the stratification upon which a town stands, or from wells sunk near to a town.

2. Storage reservoirs may be constructed to reserve the excessive rain-fall, and thus eqalise the water of a limited area as also to provide compensation for mills and water rights generally.

3. Springs which appear at the surface, and rivers may be made available; the water being brought in by aqueduct mains, should there be elevation sufficient at the source, or pumped if too low.

Birmingham having a midland position, and standing on the highest land of the district, renders it imperative that pumping be resorted to in order to supply the whole of the houses within the borough. Water might be introduced by gravitation it is true, but on so limited a scale as to preclude this means of supply being resorted to.

A public supply of water from wells sunk into the subsoil in or near the town has been suggested, and borings having been made, as also analyses of the water, we will not trouble the committee further on this head of the subject than to point out the uncertainties and inconveniences likely to arise from adopting this mode of supply.

*Local stratification.—Uncertainty of a full supply of water being obtained from wells.*—The town of Birmingham stands upon the new red sandstone foundation, which consists of marls, shales, and beds of sandstone rock of vast thickness; the whole formation is broken by faults and fissures, or dykes, vast walls of igneous rock which have been protruded from unknown depths. Some of these fissures are open, and contain water; the rock also contains water to a limited depth from the surface. Many of the faults or dykes are impervious to water, isolating areas of limited extent, and there are intervening beds of clay, shale and marl, which are as water-tight as a continuous plane of sheet lead would be.

Faults and dykes are for the most part vertical. Beds are generally horizontal. Few "dykes" are, however, perfectly "vertical," neither are "beds" always level or "horizontal." Beds "crop" to the surface, as "dykes" rise to the surface. It is important fully to understand these facts, because they must ever make sinking or boring for water a question of speculation.

The fresh water found within the crust of the earth, or which issues from it in springs is the result of rain fall, or condensation from vapour. The whole must have passed from the surface, and as a rule, the deeper the well the more mineral matter the water will contain; and further, the more nearly a well in the new red sandstone is exhausted, the harder the water becomes, by reason of a waste of the solids forming the stone. Many of the wells in Liverpool, when hard pumped, yield water having a milky tinge, by washing out the gypsum of the stone.

That wells can be exhausted, however powerful the springs apparently are when first opened, is proved by all mining operations. That wells in the new red sandstone form no exception has been proved in many places, New York, in America, Manchester and Salford, Liverpool and Wolverhampton. In Liverpool, besides the vertical shaft of the wells there are many miles of headings, and many deep borings. As the wells are pumped these are added to, and so uncertain is the present limited supply that the corporation are constructing extensive storage reservoirs at thirty miles distance. The Manchester corporation have also constructed large works of a similar character, and within this week the corporation of Wolverhampton have passed a resolution to call in some engineer, to advise as to the waterworks, &c.

*Artesian Boring.*—Many persons having read or heard of artesian wells, come to a conclusion that it is only necessary to bore deep enough and water will be obtained. The conclusion is not true neither in theory nor in fact. There must be a peculiar configuration of strata to give facilities for the formation of an artesian well. That which in geology is known as a basin formation, and even in a geological basin, there must be a peculiar order of strata,—impervious clay above, and sand or other highly porous water-bearing strata below. If a town or city, as London, Paris, &c., stand on such a basin, water may be obtained by deep boring, and is so obtained, but not to an extent anything equal to the supply of large populations. The deep wells and artesian borings in London are only used for private and commercial purposes, brewing, &c. (and generally only for cooling in these establishments), yet all the wells in the metropolis are in course of exhaustion. *The water line is reduced year by year.* Upwards of fifty millions of gallons of water are poured into the metropolis daily by the several companies, independent of any wells or springs, from the New River, from the Thames, and from other sources.

As a proof that deep sinking or boring will not answer in the new red sandstone, we may instance the experience with two deep mines sunk through it, and situate wide apart,—the Pendleton Colliery, near Manchester, the Monkwearmouth Colliery, near Sunderland. After a depth of 900 feet vertical had been obtained, the strata was found to be comparatively dry, and water had to be passed down into the workings to water the roads, they were so intolerably dusty. The water obtained at the deepest points to which it was found to penetrate was impregnated with mineral as strongly as brine. Both these shafts yielded water in profusion in the upper beds to the depth of several hundred feet. This had to be "tubbed" out by a casing of cast-iron.

That water may be obtained from wells sunk in or near Birmingham we do not deny, but we wish to impress upon the committee all the facts within our knowledge bearing on this question, and from these facts (the experience of other places similarly situated, and where the experiment has been tried and abandoned) we deduce the following rules:—

1. No large town or city can be permanently supplied from wells sunk into the strata upon which it stands. The experiment was tried in ancient Rome, in New York, in America, in Manchester and Salford, in Liverpool, and in Wolverhampton. London and Paris, notwithstanding that they stand in the most favourable situation for artesian wells, do not obtain more than a limited supply by these means.

2. The water for the supply of a large town should be visible, and should be of such extent as to preclude any possibility of failure.

3. The source of supply should be the least objectionable the district will afford, and the works should be established in such a position as to be available for any future extensions required.

*Remarks as to Pumping from Wells*, &c.—The vertical lift of water by the company is about 240 feet. Blythe Mill, near Coleshill, is about 60 feet below the pumping station at Birmingham, and allowing 4 feet per mile as an available head to overcome friction in the main, the entire lift at Blythe Mill should be about 90 feet. This would necessitate an entire lift to supply the upper portions of Birmingham of about 330 feet, the water being at the surface.

*Probable Depth of Sinking.*—Wells to be available for a large supply must be deep. The wells in Liverpool vary from 300 to 600 feet vertical, and this is probably the depth to which wells in or near Birmingham must be sunk. The entire depth of any well or wells would have to be added to the existing lift from the surface. The annual cost of pumping will be in proportion to the depth from which water is raised.

Should wells in or near Birmingham be sunk, the following table will show the relative proportion of depths:—

*Probable Depths of Wells if Sunk in or near Birmingham.*

| | Feet. | Feet. | Feet. | Feet. |
|---|---|---|---|---|
| Assumed depths | 300 | 400 | 500 | 600 |
| Company's lift added | 240 | 240 | 240 | 240 |
| Total lift required | 540 | 640 | 740 | 840 |

*Known Lift of Water, if taken from or near Blythe Mills.*

| | Feet. |
|---|---|
| Lift from proposed pumping station into fountain reservior, near Coleshill | 90 |
| Company's lift added | 240 |
| Total lift required | 330 |

Or a saving of 210 feet, should the shallowest wells indicated be found sufficient, but a saving of 510 feet lift should the deepest wells be required.

The cost of wells and headings is as uncertain as the results. The Green-lane well, near Liverpool, with engines and reservoirs, has cost about 100,000*l.*, and this is considered an eminently successful case, the well yielding about one million gallons of water each twenty-four hours, but at the cost of the surrounding district, as most of the private wells have been drained, and compensation has had to be paid.

*Proposed Source of Supply.*—Having carefully examined the water shed of the following rivers south of Tamworth, viz:—the Tame, Bourne, Cole, Blythe, Avon, Dene, and Alne, together with their tributaries within a circuit of 105 miles east and south of Birmingham, bounded by the following places:—Erdington, Sutton, Coldfield, Tamworth, Polesworth, Baddesley, Ensor, Baxterley, Fillongley, Meriden, Berkswell, Kenilworth, Stoneleigh, Warwick, Barford, Wellesbourne, Stratford-on-Avon, Wootten Wawen, Henley-in-Arden, Tanworth, and Moseley, comprising an area of 450 square miles, or 288,000 acres. We propose, out of this large district, to select for the supply of Birmingham, the water shed of the rivers Blythe and Cole, taking the combined waters of these rivers a little below their junction, in a direct line 9½ miles from the centre of Birmingham, and about 60 feet below the pumping station of the present company. There is one feature peculiar and most favourable in this case About eleven hundred yards below this point is the junction of the Tame, down which is brought the entire sewage of Birmingham, so that no heavy compensation for loss of water can be sustained, as the supply would be taken and returned into the same stream within eleven hundred yards of its point of abstraction.

*Volume of Water in the River Blythe in Dry Weather.*—We gauged the Blythe at the point stated, and (after twelve months of unusually dry weather) we found about twenty-five million gallons of water passing per day of twenty-four hours; it was clear, colourless, and tasteless, and well adapted as a supply for Birmingham. On examining the rivers Blythe and Cole, as also their tributaries, we found the water-shed free from limestone, or lime-bearing strata, and particularly favourable, the entire district being of a true agricultural character, and likely so to continue, the subsoil being composed of alluvium gravel and sand principally, or varying combinations of these. There is an area of about 144 square miles or 92,160 acres. There is no other source of supply within reach of Birmingham in any respect so eligible as the one referred to. The water is only about 9½ miles from Birmingham, and may be pumped from within a few yards of the spot to which it is again returned by gravitation, after having done its work and been purified at the sewage works now in course of construction. The next source of supply is the Avon, a Kenilworth or at Stratford; the latter place would be most eligible, but water would have to be lifted 522 feet, or 192 feet higher than that required on the Blythe. The distance from Birmingham is also greater, being twenty miles; and as it could not be returned to the Avon except at enormous expense, compensation to a ruinous amount would be exacted.

*Area of District from which the Waters of the Rivers Cole and Blyth flow.*—About one hundred and forty-four square miles, or ninety-two thousand statute acres, producing a minimum volume of water equivalent to twenty-five million gallons in each twenty-four hours. Birmingham at present requiring about six million gallons each twenty-four hours.

*Geological Character of District.*—For the most part new red sandstone. There is a small portion of coal in the Trent Valley, east of Tamworth and Coventry; but no portion of the drainage falls into the water proposed to be taken, or even can be turned into these streams. The stratified rocks are covered by alluvium sand, gravel, clay, marl, more or less separate, as also varying mixtures of these. The whole district is agricultural, and is likely to remain so, there being no manufactures carried on in the district, nor is there one town larger than Coleshill.

*Recommendations.*—We recommend that the combined waters of the rivers Cole and Blythe be taken at or about Blythe Mill. Blythe Mills consists of two small undershot water-wheels, having an available fall of about 4 feet. Three pairs of stones can be driven when in full work; for a considerable portion of the year two pairs only are worked, and for many weeks during the present year there has only been water sufficient to drive one pair of stones. On September 19th, 1854, the miller stated that he never remembered so dry a season, and consequently never saw the water so low.* That a storage or settling reservoir and filter-beds, with pumping-engines, be established at this point; that the water be raised into a covered fountain-reservoir, situate in or near Coleshill, which is about one mile distant; and that from this reservoir an acqueduct main be laid up the valley of the Tame, to or near the pumping establishment of the Birmingham Waterworks Company. The Birmingham and Derby line of railway from Coleshill may be adopted, or an independent route up the valley may be taken. The lift will only be about one-third that of the elevation from the company's engines to the service-reservoir, situate at Aston, and consequently one third of the power now used by the company, if added at the proposed Blythe Mill Station, would supply Birmingham with the same amount of water the present company can furnish. Any future addition to the power would have to be in this proportion.

*Remarks as to the Advantages of the Proposed Supply.* — The advantages of the proposed supply consist:—1. In the large area at command, upwards of ninety thousand acres, and the abundant supply of water in the driest seasons.† 2. The favourable cha-

* See *Journal*, *ante* p. 384.

† The drainage area of Liverpool is about 17,000 acres, for Manchester 27,000 acres; out of these acres one-third of the water stored is given as compensation.

racter of the subsoil (new red sandstone), and the favourable character of the surface (agricultural), free from large towns and manufactures. 3. The nearness to Birmingham (about nine and a-half miles), the moderate elevation and comparative light lift required (about 330 feet), as also the favourable gradient afforded by the valley for an aqueduct main.

*Estimate.*—For works to be capable of delivering six millions of gallons of water in each twenty-four hours at the present pumping-station, Birmingham, 111,880*l*. Engine power to the extent of 300-horse power will be required. Three engines—two working, and one in reserve.

*Remarks.*—We beg to apologise for the brief character of our report. We did not, however, feel justified in causing the delay necessary to draw up a lengthened statement. Having, by making a full examination of the district, discovered that which we consider to be a good and sufficient supply of water for the present and future wants of the inhabitants of Birmingham, we thought it to be our duty to inform the committee at the earliest possible period of this fact; and should the scheme suggested be approved, we would ask the committee to allow us to prepare a more full report, with map and estimate complete.

Robert Rawlinson, C.E.
J. Pigott Smith, C.E.

*Birmingham, September* 23, 1854.

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Appendix.—*Report of* Dr. Robert Angus Smith.

After inspecting the whole district of the drainage ground of the Birmingham water supply, I came to the following conclusion. The Birmingham water was tolerably clear in appearance when seen in a glass at the time when I went there to examine it in April last. In the reservoir it was somewhat milky; by no means inviting in appearance, but not presenting to the eye any decidedly bad features. I got a specimen of it in April, and had only time to look generally at what it contained: it was 20 degrees of hardness, and contained 80 grains of solid indigenous matter per gallon, besides organic matter, the amount of which I did not ascertain. These 20 degrees of hardness are sufficient to condemn the supply. It is needless to enter into all the evils connected with very hard water—they are well known; the great expense in washing is one of the prominent evils, and the fact that more water is needed in order to wash is another.

Every million gallons of water must require at least a ton of soap, needlessly, in washing, on account of the hardness; this is equal to 40*l*. The amount of solid matter per gallon is made up of various sorts, alkaline chiefly; such an amount is of itself a great objection to water, independent of the hardness; the taste of the water is very much injured by them, and so it happens that the water at Birmingham is most unpleasant to drink: any one accustomed to pretty good water must perceive this at once. The use of water as a beverage can never be popular at Birmingham when there is so little to encourage it: water with so many salts in it is never fresh; it feels insipid, and even nauseous. To compare it with other towns, the Manchester supply has only about 3 grains in a gallon, and is less than 2 degrees of hardness; it used to be 12, but the new waterworks were undertaken at the expense of about a million pounds, in order to improve it. The water of Glasgow has about 13 grains in a gallon, and is 6 degrees of hardness; but they are going to spend as much as Manchester, in order to improve the supply. Even London has only about 18 grains in a gallon in its supply, so much complained of, except in the very worst cases, now no longer existing, when the amount rose to 24. Liverpool is being supplied with water nearly as soft and pure as that of Manchester; and many other towns have followed, or are about to follow their example. To perpetuate such a supply as that of Birmingham, would be to ignore all that the late important inquiries into the subject have so completely established.

If we inquire what is the nature of the substances in solution, and what injury they do, we have only to go from the reservoir of the Waterworks' company at Aston a little higher into the river Tame, in order to ascertain the cause. At Sunday Bridge the stream is still less pure than at the reservoir; this is after depositing an immense amount of filthy matter in its course. There I took a specimen of the water No. 7. On examination it contains in a gallon:—

| | |
|---|---|
| Organic matter.................................. | 2·52 grs. |
| Inorganic matter, soluble .................. | 15·4 |
| Inorganic matter, insoluble ............... | 9·8 |

Going still higher to one of the nearest brooks to Birmingham (at Oldbury Green), we find a stream converted into an open sewer, in no respect differing, but having all the qualities of sewage water. I here took another specimen. This is one of the supplies of the Tame; another at Tividale, in no way different; another at Bilston, and at West Bromwich, Wednesbury, and Great Bridge.

All these places send their sewerage into the Tame, where, after running about ten miles, it is pumped up into the water-pipes and sent into Birmingham houses without change, excepting the deposit of solid matter. Now, although I have not analysed all these specimens, it is well enough known what sewage water contains. Some sewage is soluble in water, and some is insoluble; although the water is clear therefore, it is by no means on that account purer, some of the most disgusting ingredients being soluble in water.

In flood time the insoluble matter comes down, and the brook courses to some extent are purified, the solid matter being in these cases more or less carried into the reservoir.

Now, it is possible for soil to purify water from a considerable amount of sewage, as water from purely pastoral land shows, when the water sinks into the ground and comes out purified; but here the matter has no such chance, it never sinks into the ground to be purified. The sewers run directly into the river without concealment.

There is no doubt therefore that the Tame contains the sewage water from a population of at least a quarter of a million; this population covers all the ground on the banks of the river between Birmingham and Wolverhampton: there is scarcely an acre of ground not covered with works, buildings, roads, or rubbish from works of various kinds.

These villages and scattered houses are many of them in a wretched condition, as far as their sanitary arrangements are concerned. They are generally or altogether without sewers; the streets are lined with open drains: in many places these lie stagnant, and deposit green offensive matter before the houses. In all of them the flow is interrupted, and the inhabitants must suffer from them. Now, it seems quite essential that these places should at once be put in proper order. When this happens, the streams will carry away much more of their refuse, and by clearing the towns more the streams will become still more impure. Some of them are now applying to be put under the Board of Health.

At present the stream which fills the Birmingham reservoirs is the washing of fifty miles of land inhabited by a population living, to say the least, in a state so far from being conducive to health, that the whole country has been appalled by the severity with which epidemics have attacked them. Bilston itself is drained into the Tame, and even in the time of cholera sends its polluted water to be drunk at Birmingham. There is no portion of England, not even in the streets of London, so unsuited for collecting the water from as this portion; there can be no doubt whatever of this.

Besides that the river contains the washings of such a population, and the washings of so many iron and chemical works, it contains the water also from numberless coalpits which cover the district from one end to the other in perfectly marvellous numbers. Water from coalpits is never good, it contains salts of various kinds and in great variety, subject also to considerable changes. Even a coal district is often unfavourable to the water, even when it is not pumped up directly from the pit.

The rain in a busy manufacturing district is always impure, as is well known, from the blacking of the water from the house-tops, and the general blackness of rain water, however collected, in manufacturing districts; besides its blackness, we know that its taste unfits it for drinking, so that however the soil may be in the district in question, rain from such a quarter would be unfit for use.

I can only conclude by saying that in every respect the water of Birmingham is absolutely unfitted for domestic use, and for many mercantile purposes, whether calico printing, dyeing, or mere use in a boiler, and that I know of no city or town which has a supply at all to be compared with it, and the inference of course is, that the health of the inhabitants must suffer, as we know it has done in other cases not so bad, and that it becomes a matter of the greatest importance to obtain a better supply.

R. A. Smith.

## ESTIMATE FOR LIGHTHOUSE AND BEACON ON NEW SOUTH SHOAL, OFF NANTUCKET, U.S.

SYNOPSIS *of Estimate for the erection of a Pneumatic Iron Pile Lighthouse on New (Davis's) South Shoal, off Nantucket, Massachusetts. Time, four and a half years.*

| | | |
|---|---|---|
| Cost of structure: materials and labour | (a) | $89,175 50 |
| Cost of patterns | (b) | 1,000 00 |
| Expenses at foundry, offices, &c. | (c) | 18,195 00 |
| Expenses of building up and taking down structure at foundry | (d) | 7,017 50 |
| Cost of receiving and tender steamers and camels | (e) | 55,000 00 |
| Cost of pneumatic apparatus, including steam air-pump | (f) | 4,084 74 |
| Expenses of receiving-steamer first season at the shoal | (g) | 10,316 20 |
| Do...do...second...do... | (g) | 10,941 20 |
| Do...do...third...do... | (g) | 12,191 20 |
| Expenses of tender-steamer first season at the shoal | (h) | 6,620 85 |
| Do...do...second...do... | (h) | 6,995 85 |
| Do...do...third...do... | (h) | 7,745 85 |
| Expenses of workmen, &c., first season at the shoal | (i) | 10,519 95 |
| Do...do...second...do... | (i) | 10,519 95 |
| Do...do...third...do... | (j) | 9,663 75 |
| Miscellaneous expenses of construction | (k) | 6,823 75 |
| Miscellaneous expenses of dwelling | (l) | 5,522 87 |
| Cost of lenticular lighting apparatus | (m) | 8,850 00 |
| Amount | | 280,684 16 |
| Contingencies 15 per cent. | | 42,102 62 |
| Total amount | | 322,786 78 |

| | | |
|---|---|---|
| Required for first year and a-half at the foundry, &c. (n)... | $190,589 20 | |
| Do...for first year at the shoal (o)... | 40,947 76 | |
| Do...for second year......do......(p)... | 37,249 07 | |
| Do...for third year ......do... ..(q)... | 54,000 75 | |
| Total amount | | $322,786 78 |

*(a.)—Synopsis of estimate.—Materials and labour for lower or foundation section (common to beacon.)*

| | | |
|---|---|---|
| Cost of wrought-iron (r) | $16,875 65 | |
| Cost of cast-iron (s) | 4,613 79 | |
| Cost of material | | $21,489 44 |
| Labour on wrought-iron (t) | 3,721 20 | |
| Labour on cast-iron (u) | 927 00 | |
| Cost of labour | | 4,648 20 |
| *Second (double) section (common to beacon).* | | |
| Cost of wrought-iron (v) | 18,044 83 | |
| Cost of cast-iron (w) | 1,342 20 | |
| Cost of material | | 19,387 03 |
| Labour on wrought-iron (x) | 4,834 20 | |
| Labour on cast-iron (y) | 651 00 | |
| Cost of labour | | 5,485 20 |
| *Third (double) section (common to beacon).* | | |
| Cost of wrought-iron (z) | 8,201 08 | |
| Cost of cast-iron (aa) | 168 72 | |
| Cost of material | | 8,369 80 |
| Labour on wrought-iron (bb) | 1,547 20 | |
| Labour on cast-iron (cc) | 132 00 | |
| Cost of labour | | 1,679 20 |
| *Third (double) section.* | | |
| Cost of wrought-iron (hh) | 1,606 20 | |
| Cost of cast-iron (ii) | 792 00 | |
| Cost of material | | 2,398 20 |
| Labour on wrought-iron (kk) | 1,534 40 | |
| Labour on cast-iron (ll) | 400 00 | |
| Cost of labour | | 1,934 40 |
| *Fourth (double) section.* | | |
| Cost of wrought-iron (mm) | 5,483 61 | |
| Cost of cast-iron (nn) | 904 61 | |
| Cost of material | | 6,388 22 |
| Labour on wrought-iron (oo) | 1,630 56 | |
| Labour on cast-iron (pp) | 436 00 | |
| Cost of labour | | 2,066 56 |
| *House, &c., third (double) section inclusive.* | | |
| Cost of wrought-iron (qq) | 4,487 55 | |
| Cost of cast-iron (rr) | 4,035 84 | |
| Cost of material | | 8,523 39 |
| Labour on wrought-iron (ss) | 4,707 86 | |
| Labour on cast iron (tt) | 2,098 00 | |
| Cost of labour | | 6,805 86 |
| Total amount | | 89,175 50 |

### ESTIMATE FOR LIGHTHOUSE—CONTINUED.

*(c.)—Expenses at foundry, offices, &c.*

| | | |
|---|---|---|
| Agent at foundry 1½ year, 548 days, at $3 50 | $1,918 00 | |
| Books, &c., on construction, 4½ years, at $100 | 450 00 | |
| Stationery, office and drawing, 4½ years, at $75 | 337 50 | |
| Office rent, 1 office 1½ year, 2 offices 3 years, at $125 | 937 50 | |
| Office fuel at $72 each per year | 540 00 | |
| Office attendance at $48 each per year | 360 00 | |
| Clerk 4½ years, or 54 months, at $75 | 4,050 00 | |
| Draughtsman 3 years, or 36 months, at $75 | 2,700 00 | |
| Quarters and fuel for 1 major 4½ years, at $579 | 2,605 50 | |
| Quarters and fuel for 2 lieutenants 4½ years, at $313 50 each per year | 2,821 50 | |
| Transportation of baggage of 3 officers U. S. A., 4½ years, at $50 each per year | 675 00 | |
| Model of structure | 800 00 | |
| Total amount | | $18,195 00 |

*(d.)—Expenses of building up and taking down structure at foundry. Time, 7½ months of 26 days, or 195 days.*

| | | |
|---|---|---|
| 1 rigger in charge, 195 days, at $3 | 585 00 | |
| 6 machinists, 195 days, at $2 each—$12 | 2,340 00 | |
| 4 labourers, 195 days, at $1 50 each—$6 | 1,170 00 | |
| 1 blacksmith, 195 days, at $2 | 390 00 | |
| 1 striker, 195 days, at $1 50 | 292 50 | |
| 7500 feet lumber for scaffolding | 150 00 | |
| 15 spars for scaffolding, from 12 inches to 5 inches at butt | 90 00 | |
| Derrick | 500 00 | |
| Tools—drills, stocks and dies, jack-screws, rollers and bars, clamps, hammers, saws, chisels, axes, adzes, crowbars, &c., including steel for cold-chisels | 1,000 00 | |
| Blocks and falls, rigging, lashings, &c. | 500 00 | |
| Total amount | | 7,017 50 |

*(e.)—Cost of receiving and tender-steamers and camels.*

| | | |
|---|---|---|
| 1 receiving-steamer, 130 feet in length | 25,000 00 | |
| 1 tender-steamer, 90 feet in length | 15,000 00 | |
| 2 camels, 100 feet in length, at $7500 | 15,000 00 | |
| Total amount | | 55,000 00 |

*(f.)—Materials and labour for pneumatic apparatus, including steam air-pump (common to beacon).*

| | | |
|---|---|---|
| Cost of wrought-iron | 73 42 | |
| Cost of cast-iron | 2,176 32 | |
| Cost of material | | 2,249 74 |
| Labour on wrought-iron | 63 00 | |
| Labour on cast-iron | 572 00 | |
| Cost of labour | | 635 00 |
| Cost of steam air-pump | | 1,200 00 |
| Total amount | | 4,084 74 |

*(g.)—Current expenses of receiving steamer, &c., first, second, and third seasons at the shoal.*

| | | |
|---|---|---|
| 1 master .. 6 months at $100 per month | 600 00 | |
| 1 first mate .. do. 40 do. | 240 00 | |
| 1 second mate .. do. 30 do. | 180 00 | |
| 1 pilot .. do. 60 do. | 360 00 | |
| 1 first engineman .. do. 60 do. | 360 00 | |
| 1 second do. .. do. 40 do. | 240 00 | |
| 2 firemen .. do. 25 do. each | 300 00 | |
| 2 coal-heavers .. do. 20 do. do. | 240 00 | |
| 4 hands .. do. 20 do. do. | 480 00 | |
| 8 boatmen .. do. 20 do. do. | 900 00 | |
| 1 steward, 1 cook .. do. 25 do. do. | 300 00 | |
| Subsistence of 24 persons, 183 days, at 35 cents each | 1,537 20 | |
| Fuel, 3 tons coal per day, 549 tons, at $6 | 3,294 00 | |
| Repairs, 2½ per cent. on $25,000—cost of steamer | 625 00 | |
| Expenses in ordinary, 6 months, at $100 | 600 00 | |
| Total amount | | 10,316 20 |
| Second season same as the first | 10,316 20 | |
| With an additional 2½ per cent. for repairs | 625 00 | |
| Total amount | | 10,941 20 |
| Third season same as the second | 10,941 20 | |
| With an additional 5 per cent. for repairs | 1,250 00 | |
| Total amount | | 12,191 20 |

*(h.)—Current expenses of tender-steamer, &c., first, second, and third seasons at the shoal.*

| | | |
|---|---|---|
| 1 master, 6 months, at $75 per month | 440 00 | |
| 1 mate do 35 do | 210 00 | |
| 1 pilot, acting also as second mate, 6 months, at $60 per month | 360 00 | |
| 1 first engineman, 6 months, at $50 per month | 300 00 | |
| 1 second do. do. 30 do. | 180 00 | |
| 1 fireman .. do. 25 do. | 150 00 | |
| 1 coal-heaver .. do. 20 do. | 120 00 | |
| 2 hands .. do. 20 each | 240 00 | |
| 6 boatmen .. do. 20 do. do. | 720 00 | |
| 1 steward, 1 cook .. do. 25 do. do. | 300 00 | |
| Subsistence of 17 persons, 183 days, at 35 cents. | 1,088 85 | |
| Fuel, 1½ ton coal per day, 274½ tons, at $6 | 1,647 00 | |
| Repairs, 2½ per cent. on $15,000—cost of steamer | 375 00 | |
| Expenses in ordinary, 6 months, at $80 | 480 00 | |
| Total amount | | 6,620 85 |
| Second season same as first | 6,620 85 | |
| With an additional 2½ per cent. for repairs | 375 00 | |
| Total amount | | 6,995 85 |
| Third season same as second | 6,995 85 | |
| With an additional 5 per cent. for repairs | 750 00 | |
| Total amount | | 7,745 85 |

ESTIMATE FOR LIGHTHOUSE—CONTINUED.

| | | |
|---|---|---|
| *(i.)—Current expenses of workmen, &c., first or second season at the shoal.* | | |
| 1 superintendent of work, 183 days, at $5 00 | $ 915 00 | |
| 2 foremen do. 2 50 each | 915 00 | |
| 8 machinists do. 2 00 do. | 2,928 00 | |
| 2 riggers do. 2 00 do. | 782 00 | |
| 2 carpenters do. 2 00 do. | 732 00 | |
| 1 blacksmith do. 2 00 | 866 00 | |
| 1 striker do. 1 50 | 274 50 | |
| 10 labourers 6 months 25 00 each | 1,500 00 | |
| 1 steward, 1 cook do. 25 00 do. | 300 00 | |
| Subsistence of 29 persons, 183 days, at 35 cents each | 1,857 45 | |
| Total amount | | $10,519 95 |
| Second season at the shoal same as the first | | 10,519 95 |
| *(j.)—Current expenses of workmen, &c., third season at the shoal.* | | |
| 1 superintendent of work, 183 days, at $5 00 | 915 00 | |
| 2 foremen do. 2 50 each | 915 00 | |
| 5 machinists do. 2 00 do. | 1,830 00 | |
| 2 riggers do. 2 00 do. | 732 00 | |
| 5 carpenters do. 2 00 do. | 1,830 00 | |
| 1 blacksmith do. 2 00 | 366 00 | |
| 1 striker do. 1 50 | 274 50 | |
| 6 labourers 6 months 25 00 each | 900 00 | |
| 1 steward, 1 cook do. 25 00 do. | 300 00 | |
| Subsistence of 25 persons, 183 days, at 35 cents each | 1,601 25 | |
| Total amount | | 9,663 75 |
| *(k.)—Miscellaneous expenses of construction.* | | |
| Freight of structure from foundry to harbour of departure and refuge, 640 tons, at $1 75 | 1,120 00 | |
| Wharfage at harbour of departure and refuge, 3 years, at $500 | 1,500 00 | |
| Temporary store-houses on wharf at harbour of departure and refuge | 250 00 | |
| Paints and paint-oils, &c., and paint-brushes, for ironwork | 350 00 | |
| 6 disc buoys, 500 lb. each, at $32 50 each | 195 00 | |
| 6 disc buoys, 350 lb. each, at $27 50 each | 165 00 | |
| 7500 feet lumber, for scaffolding, including freight, at $27 50 per thousand | 206 25 | |
| Derrick for work at the shoal | 500 00 | |
| Blocks and falls, rigging, lashings, &c. | 1,000 00 | |
| 2 portable forges, at $36 | 72 00 | |
| Blacksmiths' tools for forges, at $64 | 128 00 | |
| 3 riveting furnaces, at $25 | 75 00 | |
| 750 bushels blacksmiths' coal, at 25 cents | 187 50 | |
| 4 boats, 2 of 8 oars, 2 of 6 oars, at $250 | 1,000 00 | |
| Freight of derrick, blocks and falls, forges, furnaces, &c. | 75 00 | |
| Total amount | | 6,823 75 |
| *(l.)—Miscellaneous expenses of dwelling, &c.* | | |
| 1 boat | 250 00 | |
| 1 dingy, metal life-boat | 135 00 | |
| 3 water-tanks, boiler-iron, $203 85; rivets, $21 40; labour, $300 | 525 25 | |
| 6 tin oil-butts, 24 by 72 inches, with drip-pans, at $20 50 | 123 00 | |
| 1 fog-bell, 3000 lb. at 25 cents | 750 00 | |
| 1 striking machinery for fog-bell | 375 00 | |
| 1 cooking-room, 1 sitting-room, and 1 watching-room stove | 100 00 | |
| Furniture, cooking and table, bedding, &c. | 300 00 | |
| 21,000 feet worked flooring boards to line dwelling, including freight, at $42 per thousand | 945 00 | |
| Carpenter-work on doors, sash, casings, &c. | 300 00 | |
| Hardware for dwelling; locks, hinges, nails, &c. | 150 00 | |
| Glass for dwelling; 228 lights, at 25 cents | 57 00 | |
| Glass for lantern; 96 lights at $12 | 1,152 00 | |
| Paints, paint oils, &c., and paint-brushes, for dwelling, watch-room and lantern | 200 00 | |
| Tools for repairing lighting apparatus, dwelling, &c. | 170 62 | |
| Total amount | | 5,522 87 |
| *(m.)—Cost of lenticular lighting apparatus, &c.* | | |
| Lenticular lighting apparatus, 1st order fixed | 8,000 00 | |
| Fixtures and expenses for same | 350 00 | |
| Total amount | | 8,350 00 |
| *(n.)—Expenses of first year and a half at foundry, &c.* | | |
| Agent at foundry | 1,918 00 | |
| Books, &c., on construction; stationery, office and drawing | 262 50 | |
| Office rent, office fuel, office attendance | 367 50 | |
| Clerk and draughtsman | 2,700 00 | |
| Cost of structure—materials and labour | 89,175 50 | |
| Cost of patterns and model of structure | 1,800 00 | |
| Cost of pneumatic apparatus, including steam air-pump | 4,084 74 | |
| Expenses of building up and taking down structure at foundry | 7,017 50 | |
| Cost of receiving and tender steamers and camels | 55,000 00 | |
| Freight of structure from foundry to harbour of departure and refuge | 1,120 00 | |
| Temporary storehouse at harbour of departure and refuge | 250 00 | |
| Quarters and fuel for 1 major and 2 lieutenants | 1,809 00 | |
| Transportation of baggage of 3 officers U. S. army | 225 00 | |
| | | 165,729 74 |
| Contingencies, 15 per cent. | | 24,859 46 |
| Total amount required for first year and a half at foundry, &c. | | 190,589 20 |

ESTIMATE FOR LIGHTHOUSE—CONTINUED.

| | | |
|---|---|---|
| *(o.)—Expenses of first year at the shoal.* | | |
| Current expenses of receiving-steamer | $10,316 20 | |
| Do. do. tender-steamer | 6,620 85 | |
| Wharfage at harbour of departure and refuge | 500 00 | |
| Paints, oils, &c., and paint-brushes, for ironwork | 350 00 | |
| 12 disc buoys | 360 00 | |
| Lumber for scaffolding, including freight | 206 25 | |
| Derrick, blocks and falls, rigging, &c. | 1,500 00 | |
| Portable forges, furnaces, blacksmiths' tools, blacksmiths' coal | 337 50 | |
| 4 boats—2 of 8 oars, 2 of 6 oars | 1,000 00 | |
| Freight of derrick, blocks and falls, forges, furnaces, &c. | 75 00 | |
| Current expenses of workmen, &c. | 10,519 95 | |
| Books, &c., on construction; stationery, office and drawing | 175 00 | |
| Office rent, office fuel, office attendance | 490 00 | |
| Clerk and draughtsman | 1,800 00 | |
| Quarters and fuel for 1 major and 2 lieutenants | 1,206 00 | |
| Transportation of baggage of 3 officers U. S. army | 150 00 | |
| | | $35,606 75 |
| Contingencies, 15 per cent. | | 5,341 01 |
| Total amount required for first year at the shoal | | 40,947 76 |
| *(p.)—Expenses of second year at the shoal.* | | |
| Current expenses of receiving-steamer | 10,941 20 | |
| Do. do. tender-steamer | 6,995 85 | |
| Wharfage at harbour of departure and refuge | 500 00 | |
| Blacksmiths' coal | 62 50 | |
| Current expenses of workmen, &c. | 10,519 95 | |
| Books, &c., on construction; stationery, office and drawing | 175 00 | |
| Office rent, office fuel, office attendance | 490 00 | |
| Clerk | 900 00 | |
| Draughtsman 6 months | 450 00 | |
| Quarters and fuel for 1 major and 2 lieutenants | 1,206 00 | |
| Transportation of baggage of 3 officers U. S. army | 150 00 | |
| | | 32,390 50 |
| Contingencies, 15 per cent. | | 4,858 57 |
| Total amount required for second year at the shoal | | 37,249 07 |
| *(q.)—Expenses of third year at the shoal.* | | |
| Current expenses of receiving-steamer | 12,191 20 | |
| Do. do. tender-steamer | 7,745 85 | |
| Wharfage at harbour of departure and refuge | 500 00 | |
| Blacksmiths' coal | 62 50 | |
| Current expenses of workmen, &c. | 9,663 75 | |
| Books, &c. on construction: stationery, office and drawing | 175 00 | |
| Office rent, office fuel, office attendance | 490 00 | |
| Clerk | 900 00 | |
| Quarters and fuel for 1 major and 2 lieutenants | 1,206 00 | |
| Transportation of baggage of 3 officers U. S. army | 150 00 | |
| Cost of lenticular lighting apparatus | 8,350 00 | |
| Miscellaneous expenses of dwelling | 5,522 87 | |
| | | 46,957 17 |
| Contingencies, 15 per cent. | | 7,043 58 |
| Total amount required for third year at the shoal | | 54,000 75 |

## ESTIMATE FOR BEACON.

SYNOPSIS *of Estimate for the erection of a Pneumatic Iron Pile Beacon on New (Davis's) South Shoal, off Nantucket, Massachusetts. Time, three years.*

| | | |
|---|---|---|
| Cost of structure: materials and labour | (a') | $66,159 05 |
| Cost of patterns | (b') | 425 00 |
| Expenses at foundry, offices, &c. | (c') | 12,045 50 |
| Expenses of building up and taking down structure at foundry | (d') | 4,945 00 |
| Cost of receiving and tender-steamers and camels | (e') | 55,000 00 |
| Cost of pneumatic apparatus, including steam air-pump | (f') | 4,084 74 |
| Expenses of receiving-steamer first season at the shoal | (g') | 10,316 20 |
| Do. do. second season do. | (g') | 10,941 20 |
| Do. tender-steamer first season do. | (h') | 6,620 85 |
| Do. do. second season do. | (h') | 6,995 85 |
| Do. workmen, &c., first season do. | (i') | 10,519 95 |
| Do. do. second season do. | (i') | 10,519 95 |
| Miscellaneous expenses of construction | (k') | 5,483 00 |
| Amount | | 204,056 29 |
| Contingencies, 15 per cent. | | 30,608 44 |
| Total amount | | 234,664 73 |
| Required for first year at foundry, &c. | (n') | 157,530 21 |
| Do. do. at the shoal | (o') | 40,446 07 |
| Do. second year at the shoal | (p') | 36,688 45 |
| Total amount | | 234,664 73 |

## ESTIMATE FOR BEACON.

| | | |
|---|---|---|
| *(a'.)—Materials and labour for lower or foundation section (common to light-house).* | | |
| Cost of wrought-iron (r) | $16,875 65 | |
| Cost of cast-iron (s) | 4,613 79 | |
| Cost of material | | $21,489 44 |
| Labour on wrought-iron (t) | 3,721 20 | |
| Labour on cast-iron (u) | 927 00 | |
| Cost of labour | | 4,648 20 |
| *Second (double) section (common to light-house).* | | |
| Cost of wrought-iron (v) | 18,044 88 | |
| Cost of cast-iron (w) | 1,342 20 | |
| Cost of material | | 19,387 08 |
| Labour on wrought-iron (x) | 4,834 20 | |
| Labour on cast-iron (y) | 651 00 | |
| Cost of labour | | 5,485 20 |
| *Third (double) section (common to light-house).* | | |
| Cost of wrought-iron (z) | 8,201 08 | |
| Cost of cast-iron (aa) | 168 72 | |
| Cost of material | | 8,369 80 |
| Labour on wrought-iron (bb) | 1,547 20 | |
| Labour on cast-iron (cc) | 132 00 | |
| Cost of labour | | 1,679 20 |
| *Third (double) section.* | | |
| Cost of wrought-iron (dd) | 728 49 | |
| Cost of cast-iron (ee) | 3,150 49 | |
| Cost of material | | 3.878 98 |
| Labour on wrought-iron (ff) | 882 20 | |
| Labour on cast-iron (gg) | 339 00 | |
| Cost of labour | | 1,221 20 |
| Total amount | | 66,159 05 |
| *(c'.)—Expenses at foundry, offices, &c.* | | |
| Agent at foundry, 1 year—365 days, at $3 50 | 1,277 50 | |
| Books, &c., on construction, 3 years, at $100 | 300 00 | |
| Stationery, office and drawing, 3 years, at $75 | 225 00 | |
| Office rent—1 office, 1 year; 2 offices, 2 years—at $125 | 625 00 | |
| Office fuel, at $72 each per year | 360 00 | |
| Office attendance, at $48 each per year | 240 00 | |
| Clerk, 3 years, or 36 months, at $75 | 2,700 00 | |
| Draughtsman, 2 years, or 24 months, at $75 | 1,800 00 | |
| Quarters and fuel—1 major, three years, at $579 | 1,737 00 | |
| Do. do. 2 lieutenants, 3 years, at $313 50 each per year | 1,881 00 | |
| Transportation of baggage of 3 officers U. S. A., 3 years, at $50 each per year | 450 00 | |
| Model of structure | 450 00 | |
| Total amount | | 12,045 50 |
| *(d'.)—Expenses of building up and taking down structure of foundry.—Time, 5 months of 26 days, or 130 days.* | | |
| 1 rigger, in charge, 130 days, at $3 | 390 00 | |
| 6 machinists, 130 days, at $2 each—$12 | 1,560 00 | |
| 4 labourers, 130 days, at $1 50 each—$6 | 780 00 | |
| 1 blacksmith, 130 days, at $2 | 260 00 | |
| 1 striker, 130 days, at $1 50 | 195 00 | |
| 5000 feet lumber for scaffolding, at $20 | 100 00 | |
| 10 spars for scaffolding, from 12 inches to 5 inches at butt | 60 00 | |
| Derrick | 500 00 | |
| Tools—drills, stocks and dies, jackscrews, rollers and bars, clamps, crowbars, hammers, saws, chisels, axes, adzes, &c., including steel for cold chisels | 700 00 | |
| Blocks and falls, rigging, lashings, &c. | 400 00 | |
| Total amount | | 4,945 00 |
| *(e'.)—Cost receiving and tender-steamers and camels.* | | |
| 1 receiving-steamer, 130 feet in length | 25,000 00 | |
| 1 tender-steamer, 90 feet in length | 15,000 00 | |
| 2 camels, 100 feet in length, at $7500 | 15,000 00 | |
| Total amount | | 55,000 00 |
| *(f'.)—Materials and labour for pneumatic apparatus, including steam air-pump (common to light-house).* | | |
| Cost of wrought-iron | 73 42 | |
| Cost of cast-iron | 2,176 32 | |
| Cost of material | | 2,249 74 |
| Labour on wrought-iron | 63 00 | |
| Labour on cast-iron | 572 00 | |
| Cost of labour | | 635 00 |
| Cost of steam air-pump | | 1,200 00 |
| Total amount | | 4,084 74 |
| *(g'.)—Current expenses of receiving-steamer, &c., first and second seasons at the shoal.* | | |
| 1 master, 6 months, at $100 per month | 600 00 | |
| 1 first mate, 6 months, at $40 per month | 240 00 | |
| 1 second mate, 6 months, at $30 per month | 180 00 | |
| 1 pilot, 6 months, at $60 per month | 360 00 | |
| 1 first engineman, 6 months, at $60 per month | 360 00 | |
| 1 second do. 6 months, at $40 per month | 240 00 | |
| 2 firemen, 6 months, at $25 per month each | 300 00 | |
| 2 coal-heavers, 6 months, at $20 per month each | 240 00 | |
| 4 hands, 6 months, at $20 per month each | 480 00 | |
| 8 boatmen, 6 months, at $20 per month each | 960 00 | |

## ESTIMATE FOR BEACON—Continued.

| | | |
|---|---|---|
| 1 steward, 1 cook, 6 months, at $25 per month each | $300 00 | |
| Subsistence of 24 persons, 183 days, at 35 cents each | 1,537 20 | |
| Fuel, 3 tons coal per day, 549 tons, at $6 | 3,294 00 | |
| Repairs, 2½ per cent. on $25,000, cost of steamer | 625 00 | |
| Expenses in ordinary, 6 months, at $100 | 600 00 | |
| Total amount | | $10,816 20 |
| Second season same as the first | 10,816 20 | |
| With an additional 2½ per cent. for repairs | 625 00 | |
| Total amount | | 10,941 20 |
| *(h'.)—Current expenses of tender-steamer, &c., first and second seasons at the shoal.* | | |
| 1 master, 6 months, at $75 per month | 450 20 | |
| 1 mate, 6 months, at $35 per month | 210 00 | |
| 1 pilot, acting also as second mate, 6 months, at $60 per month | 360 00 | |
| 1 first engineman, 6 months, at $50 per month | 300 00 | |
| 1 second do. 6 months, at $30 per month | 180 00 | |
| 1 fireman, 6 months, at $25 per month | 150 00 | |
| 1 coal-heaver, 6 months, at $20 per month | 120 00 | |
| 2 hands, 6 months, at $20 per month each | 240 00 | |
| 6 boatmen, 6 months, at $20 per month each | 720 00 | |
| 1 steward, 1 cook, 6 months, at $25 per month each | 300 00 | |
| Subsistence of 17 persons, 183 days, at 35 cents each | 1,088 85 | |
| Fuel, 1½ ton coal per day, 274½ tons, at $6 | 1,647 00 | |
| Repairs, 2½ per cent. on $15,000, cost of steamer | 375 00 | |
| Expenses in ordinary, 6 months, at $80 | 480 00 | |
| Total amount | | 6,620 85 |
| Second season same as first | 6,620 85 | |
| With an additional 2½ per cent. for repairs | 375 00 | |
| Total amount | | 6,995 85 |
| *(i'.)—Current expenses of workmen, &c., first and second seasons at the shoal.* | | |
| 1 superintendent of work, 183 days, at $5 | 915 00 | |
| 2 foremen, 183 days, at $2 50 each | 915 00 | |
| 8 machinists, 183 days, at $2 each | 2,928 00 | |
| 2 riggers, 183 days, at $2 each | 732 00 | |
| 2 carpenters, 183 days, at $2 each | 732 00 | |
| 1 blacksmith, 183 days, at $2 | 366 00 | |
| 1 striker, 183 days, at $1 50 | 274 50 | |
| 10 labourers, 6 months, at $25 each | 1,500 00 | |
| 1 steward, 1 cook, 6 months, at $25 each | 300 00 | |
| Subsistence of 29 persons, 183 days, at 35 cents each | 1,857 49 | |
| Total amount | | 10,519 95 |
| Second season at the shoal same as the first | | 10,519 95 |
| *(k'.)—Miscellaneous expenses of construction.* | | |
| Freight of structure from foundry to harbour of departure and refuge, 466 tons, $1 75 | 815 50 | |
| Wharfage at harbour of departure and refuge, 2 years, at $500 | 1,000 00 | |
| Temporary wharf-house on wharf at harbour of departure and refuge | 250 00 | |
| Paints, and paint-oils, &c., and paint-brushes, for ironwork | 300 00 | |
| 6 disc-buoys, 500 lb. each, at $32 50 each | 195 00 | |
| 6 do. 350 lb. each, at $27 50 | 165 00 | |
| 5000 feet lumber for scaffolding, including freight, at $27 50 per thousand | 137 50 | |
| Derrick for the work at the shoal | 500 00 | |
| Blocks and falls, rigging, lashings, &c. | 800 00 | |
| 2 portable forges, at $36 each | 72 00 | |
| Blacksmiths' tools for do., at $64 each | 128 00 | |
| 200 bushels of blacksmiths' coal, at 25 cents | 50 00 | |
| 4 boats— 2 of 8 oars, 2 of 6 oars—at $250 | 1,000 00 | |
| Freight of derrick, blocks and falls, forges, &c. | 70 00 | |
| Total amount | | 5,483 00 |
| *(n'.)—Expenses of first year at foundry, &c.* | | |
| Agent at foundry | 1,277 50 | |
| Books, &c., on construction; stationery, office and drawing | 175 00 | |
| Office rent, office fuel, office attendance | 245 00 | |
| Clerk and draughtsman | 1,800 00 | |
| Cost of structure, materials and labour | 66,159 05 | |
| Cost of patterns and model of structure | 375 00 | |
| Cost of pneumatic apparatus, including steam air-pump | 4,084 74 | |
| Expenses of building up and taking down structure at foundry | 4,945 00 | |
| Cost of receiving and tender-steamers and camels | 55,000 00 | |
| Freight of structure from foundry to harbour of departure and refuge | 815 50 | |
| Temporary store-house at harbour of departure and refuge | 250 00 | |
| Quarters and fuel for 1 major and 2 lieutenants | 1,206 00 | |
| Transportation of baggage of 3 officers U. S. A. | 150 00 | |
| Total amount | | 136,982 79 |
| Contingencies, 15 per cent. | | 20,547 42 |
| Total amount required for first year at foundry, &c. | | 157,530 21 |

ESTIMATE FOR BEACON—CONTINUED.

| | | |
|---|---|---|
| *(o'.)—Expenses of first year at shoal.* | | |
| Current expenses of receiving-steamer .. .. .. | $10,316 20 | |
| Current expenses of tender-steamer .. .. .. | 6,620 85 | |
| Wharfage at harbour of departure and refuge .. .. | 500 00 | |
| Paints, paint-oils, &c., and paint-brushes for ironwork .. | 300 00 | |
| 12 disc-buoys .. .. .. .. .. .. .. | 360 00 | |
| Lumber for scaffold, including freight .. .. .. | 137 50 | |
| Derrick, blocks and falls, rigging, &c. .. .. .. | 1,300 00 | |
| Portable forges, blacksmiths' tools, blacksmiths' coal .. | 225 00 | |
| 4 boats, 2 of 8 oars, 2 of 6 oars .. .. .. .. .. | 1,000 00 | |
| Freight of derrick, blocks and falls, forges, &c. .. .. | 70 00 | |
| Current expenses of workmen, &c. .. .. .. .. | 10,519 96 | |
| Books, &c., on construction; stationery, office and drawing | 175 00 | |
| Office rent, office fuel, office attendance .. .. .. | 490 00 | |
| Clerk and draughtsman .. .. .. .. .. .. | 1,800 00 | |
| Quarters and fuel for 1 major and 2 lieutenants .. .. | 1,206 00 | |
| Transportation of baggage of 3 officers U. S. A. .. .. | 150 00 | |
| Total amount .. .. .. .. .. | .. .. .. | $35,170 50 |
| Contingencies, 15 per cent. .. .. .. .. .. .. | .. .. .. | 5,275 57 |
| Total amount required for first year at the shoal .. | .. .. .. | 40,446 07 |

| | | |
|---|---|---|
| *(p'.)—Expenses of second year at the shoal.* | | |
| Current expenses of receiving-steamer .. .. .. | 10,941 20 | |
| Current expenses of tender-steamer .. .. .. | 6,995 85 | |
| Wharfage at harbour of departure and refuge .. .. | 500 00 | |
| Blacksmiths' coal .. .. .. .. .. .. | 25 00 | |
| Current expenses of workmen, &c. .. .. .. .. | 10,519 96 | |
| Books, &c., on construction; stationery, office and drawing | 175 00 | |
| Office rent, office fuel, office attendance .. .. .. | 490 00 | |
| Clerk .. .. .. .. .. .. .. .. .. | 900 00 | |
| Quarters and fuel for 1 major and 2 lieutenants .. .. | 1,206 00 | |
| Transportation of baggage of 3 officers U. S. A. .. .. | 150 00 | |
| Total amount .. .. .. .. .. | .. .. .. | 31,903 00 |
| Contingencies, 15 per cent. .. .. .. .. .. .. | .. .. .. | 4,785 45 |
| Total amount required for second year at the shoal .. | .. .. .. | 36,688 45 |

## *Detailed Estimate for Materials and Labour of both Lighthouse and Beacon (a).*

| | | |
|---|---|---|
| LOWER OR FOUNDATION (DOUBLE) SECTION, COMMON TO BOTH LIGHT-HOUSE AND BEACON. | | |
| *Material—wrought-iron.—(r.)* | | |
| 9 12-inch piles (hammered scrap), 13,347 lb. each, at 7½ cents, $1001 02 each .. .. .. .. | 9,009 18 | |
| 2 centre collars for spider-web braces, 3228 lb. each, at 6 cents, $193 68 each .. .. .. .. .. | 387 36 | |
| 16 periphery collars for spider-web braces, 1353 lb. each, at 6 cents, $81 18 each .. .. .. .. | 1,298 88 | |
| 48 spider-web braces (16 periphery, 16 radial, 16 chord), 6 by 4 inches, 101,871 lb. at 4 cents .. .. | 4,074 84 | |
| 48 diagonal braces (16 panel, 16 radial, 16 chord), 3-inch round iron, 43,762 lb. at 3½ cents .. .. .. .. | 1,531 67 | |
| 96 turn-buckles for diagonal braces, 9863 lb. at 4 cents | 394 52 | |
| 4480 lb. bolt and bar iron, assorted sizes, for bolts, nuts, straps, &c., for section, at 4 cents .. .. .. | 179 20 | |
| | | 16,875 65 |
| *Material—cast-iron —(s).* | | |
| 9 cylinders with cones, 11,745 lb. each, at 3 cents $352 35 each .. .. .. .. .. .. .. .. | 3,171 15 | |
| 9 sleeves or couplings, 3896 lb. each, at 3 cents, $116 88 each .. .. .. .. .. .. .. .. | 1,051 92 | |
| 16 periphery collars for spider-web braces, 187 lb. each, at 3 cents, $5 61 each .. .. .. .. .. | 89 76 | |
| 24 diagonal brace clasps (8 panel, 16 chord), 54 lb. each, 1296 lb. at 3 cents .. .. .. .. .. | 88 88 | |
| 16 diagonal brace clasps (radial chord), 1344 lb. at 3 cents | 40 32 | |
| 16 spider-web brace clasps (chord), 4192 lb. at 3 cents .. | 125 76 | |
| 16 spider-web brace clasps (radial and chord), 3200 lb. at 3 cents .. .. .. .. .. .. .. | 96 00 | |
| | | 4,618 79 |
| *Labour on wrought-iron.—(t).* | | |
| 9 12-inch piles (hammered scrap), turning each 5 feet, 45 feet, at $6, $270; and turning to lengths, at $6, $54 | 324 00 | |
| 2 centre collars for spider-web braces, planing, turning, chipping, boring bolt holes, riveting bolts, &c., at $85 | 170 00 | |
| 16 periphery collars for spider-web braces, turning, chipping, boring bolt holes, riveting bolts, &c., at $42 .. | 672 00 | |
| 48 spider-web braces (16 periphery, 16 radial, 16 chord), forging, chipping, and boring bolt holes, &c., at $12 each all round .. .. .. .. .. .. | 576 00 | |
| 48 diagonal braces (16 panel, 16 radial, 16 chord), 3-inch round iron, welding, heading, cutting screws, &c., $7 50 each all round .. .. .. .. | 360 00 | |
| 96 turn-buckles, forging, turning, cutting screws, &c., at $15 .. .. .. .. .. .. .. | 1,440 00 | |
| 4480 lb. bolt and bar iron, assorted sizes for bolts, nuts, straps, &c. for section, at 4 cents .. .. .. .. | 179 20 | |
| | | 3,721 20 |
| *Labour on cast-iron.—(u).* | | |
| 9 cylinders with cones, boring each 3 feet, 27 feet, at $6 | 162 00 | |
| 9 fixtures, &c., for attaching collars, pipeing, &c, at $15 | 135 00 | |
| 9 sleeves or couplings, boring each 4 feet, 36 feet, at $6, $216 and turning for attaching collars, &c., at $10, $90 | 306 00 | |
| 16 periphery collars for spider-web braces, planing, &c., at $8 .. .. .. .. .. .. .. .. | 128 00 | |
| 40 clasps (8 panel, 16 chord, 16 radial and chord), at $2 50 | 100 00 | |
| 32 spider-web clasps (16 radial, 16 chord), at $3 .. | 96 00 | |
| | | 927 00 |

ESTIMATE FOR MATERIALS AND LABOUR—CONTINUED.

| | | |
|---|---|---|
| SECOND (DOUBLE) SECTION, COMMON TO BOTH LIGHT-HOUSE AND BEACON. | | |
| *Material—wrought-iron.—(v).* | | |
| 1 12-inch centre pile (hammered scrap), 14,300 lb. at 7½ cents .. .. .. .. .. .. .. .. | $1,072 50 | |
| 8 periphery piles, from 12-inch tapering to 10½ inch (hammered scrap), 12,636 lb. each, at 9 cents, $1137 24 each | 9,097 92 | |
| 24 spider-web braces (8 periphery, 8 radial, 8 chord), 6 by 4 inches, 36,985 lb. at 4 cents .. .. . | 1,479 40 | |
| 80 diagonal braces (32 panel, 32 radial, 16 chord), 3-inch round iron, 62,874 lb. at 3½ cents .. .. .. .. | 2,200 59 | |
| 24 spider-web braces (8 periphery, 8 radial, 8 chord), 6 by 4 inches, 45,421 lb. at 4 cents .. .. .. | 1,816 84 | |
| 160 turn-buckles for diagonal braces, 16,438 lb. at 4 cents | 657 52 | |
| 1 centre collar for spider-web braces, 3228 lb. at 6 cents | 193 68 | |
| 1 cap of centre collar, floor of house, 805 lb. at 6 cents .. | 48 30 | |
| 16 periphery collars for spider-web braces, 1353 lb. each, at 6 cents, $81 18 each .. .. .. .. .. | 1,298 88 | |
| 4480 lb. bolt and bar iron, assorted sizes for bolts, nuts, straps, &c., for section, at 4 cents .. .. .. .. | 179 20 | |
| | | $18,044 83 |
| *Material—cast-iron —(w).* | | |
| 8 sleeves or couplings, 3602 lb. each, at 3 cents, $108 06 each .. .. .. .. .. .. .. .. | 864 48 | |
| 1 centre collar, floor of house, 2516 lb. at 3 cents .. .. | 75 48 | |
| 16 periphery collars for spider-web braces, 187 lb. each, at 3 cents, $5 61 each .. .. .. .. .. | 89 76 | |
| 56 diagonal brace-clasps (16 panel, 24 chord, 16 radial), 3024 lb. at 3 cents .. .. .. .. .. | 90 72 | |
| 16 spider-web brace clasps (chord), 4192 lb. at 3 cents .. | 125 76 | |
| Do. (radial), 3200 lb. at 3 cents .. | 96 00 | |
| | | 1,342 20 |
| *Labour on wrought-iron.—(x).* | | |
| 1 12-inch centre-pile (hammered scrap) turning 6 feet, at $6, $36; and turning to length, chipping, &c., $6 .. | 42 00 | |
| 8 periphery piles, from 12-inch tapering to 10½-inch, (hammered scrap), turning each 4 feet, 32 feet, at $6, $192; and turning to length, slot and chipping, at $10, $80 .. .. .. .. .. .. .. .. | 272 00 | |
| 48 spider-web braces (16 periphery, 16 radial, 16 chord), forging, chipping, boring bolt holes, &c., at $12 each all round .. .. .. .. .. .. .. .. | 576 00 | |
| 80 diagonal braces (32 panel, 32 radial, 16 chord), welding, heading, cutting screws, &c., at $7 50 each all round | 600 00 | |
| 160 turn-buckles for diagonal braces, forging, turning, cutting, screws, &c., at $15 .. .. .. .. | 2,400 00 | |
| 1 centre collar for spider-web braces, turning, planing, chipping, boring bolt holes, riveting bolts, &c. .. .. | 85 00 | |
| 1 cap of centre collar, floor of house, chipping, boring, bolt holes, &c. .. .. .. .. .. .. | 8 00 | |
| 16 periphery collars for spider-web braces, turning, chipping, boring bolt holes, riveting bolts, &c., at $42 .. | 672 00 | |
| 4480 lb. bolt and bar iron, assorted sizes, for bolts, nuts, straps, &c., for section, at 4 cents .. .. .. | 179 20 | |
| | | 4,834 20 |
| *Labour on cast-iron.—(y).* | | |
| 8 sleeves or couplings, boring each 4 feet, 32 feet, at $6, $192; and turning for attaching collars, &c., $10, $80 | 272 00 | |
| 1 centre collar, floor of house, boring 1½ foot, at $6, $9; and chipping, &c., $6 .. .. .. .. .. | 15 00 | |
| 16 periphery collars for spider-web braces, planing, &c., at $8 .. .. .. .. .. .. .. .. | 128 00 | |
| 56 diagonal brace-clasps (16 panel, 24 chord, 16 radial), chipping, boring bolt holes, &c., at $2 50 each .. .. | 140 00 | |
| 32 spider-web brace-clasps (16 chord, 16 radial), chipping, boring bolt holes, &c.. at $3 each .. .. .. | 96 00 | |
| | | 651 00 |

| | | |
|---|---|---|
| THIRD (DOUBLE) SECTION, COMMON TO BOTH LIGHT-HOUSE AND BEACON. | | |
| *Material—wrought-iron.—(z).* | | |
| 8 periphery piles, from 10½-inch tapering to 8-inch (hammered scrap), 8746 lb. each, at 9 cents, $787 14 each .. | 6,297 12 | |
| 24 spider-web braces (8 periphery, 8 radial, 8 chord), 5 by 3 inches, 19,561 lb. at 4 cents .. .. .. .. | 780 64 | |
| 16 diagonal braces (panel), 2½-inch round iron, 6408 lb. at 3½ cents .. .. .. .. .. .. .. .. | 224 28 | |
| 32 turn-buckles for diagonal braces 1760 lb. at 4 cents .. | 70 40 | |
| 8 periphery collars for spider-web braces 1353 lb. each at 6 cents, $81 18 each .. .. .. .. .. .. | 649 44 | |
| 4480 lb. bolt and bar iron, assorted sizes, for bolts, nuts, straps, &c., for section, at 4 cents .. .. .. | 179 20 | |
| | | 8,201 08 |
| *Material—cast-iron —(aa).* | | |
| 8 periphery collars for spider-web braces, 187 lb. each at 3 cents, $5 61 each .. .. .. .. .. | 44 88 | |
| 8 diagonal brace-clasps (panel), 432 lb. at 3 cents .. | 12 96 | |
| 8 spider-web brace-clasps (chord), 2096 lb. at 3 cents .. | 62 88 | |
| 8 spider-web brace-clasps (radial), 1600 lb. at 3 cents .. | 48 00 | |
| | | 168 72 |
| *Labour on wrought-iron.—(bb).* | | |
| 8 periphery piles, from 10½-inch tapering to 8-inch (hammered scrap), turning each 4 feet, 32 feet, at $6, $192; and turning to length, slot and chipping, at $10, $80 | 272 00 | |
| 24 spider-web braces (8 periphery, 8 radial, 8 chord), forging, chipping, bolt holes, &c., at $10 each all round | 240 00 | |
| 16 diagonal braces (panel), welding, heading, cutting screws, &c., at $7 50 each .. .. .. .. .. | 120 00 | |
| 32 turn-buckles for diagonal braces, forging, turning, cutting screws, &c., at $12 50 each .. .. .. | 400 00 | |
| 8 periphery collars for spider-web braces, turning, chipping, boring bolt holes, riveting bolts, &c., at $42 each | 336 00 | |
| 4480 lb. bolt and bar iron, assorted sizes, for bolts, nuts, straps, &c., for section, at 4 cents .. .. .. .. | 179 20 | |
| | | 1,547 20 |

*Labour on cast-iron.—(cc).*

| | | |
|---|---|---|
| 8 periphery collars for spider-web braces, planing, &c., at $8 | $64 00 | |
| 8 diagonal brace-clasps (panel), chipping, boring bolt holes, &c., at $2 50 | 20 00 | |
| 16 spider-web brace-clasps (8 chord, 8 radial), chipping, boring bolt holes, &c., at $3 | 48 00 | |
| | | $132 00 |

THIRD (DOUBLE) SECTION, NOT COMMON TO LIGHT-HOUSE.

*Material—wrought-iron.—(dd).*

| | | |
|---|---|---|
| 16 diagonal braces (chord), 2½-inch round iron, 10,146 lb. at 3½ cents | 355 11 | |
| 32 turn-buckles for diagonal braces, 1760 lb. at 4 cents | 70 40 | |
| 8 diagonal braces (chord), 2-inch round iron, 2888 lb. at 3½ cents | 101 08 | |
| 16 turn-buckles for diagonal braces, 405 lb. at 4 cents | 16 20 | |
| 1 pinnacle rod, 103 lb. at 3½ cents | 3 60 | |
| 4 bolt-rods in cupola, 83 lb. at 3½ cents | 2 90 | |
| 4480 lb. bolt and bar iron, assorted sizes, for bolts, nuts, straps, &c., for section, at 4 cents | 179 20 | |
| | | 728 49 |

*Material—cast-iron.—(ee).*

| | | |
|---|---|---|
| 16 diagonal brace-clasps (chord), 864 lb. at 3 cents | 25 92 | |
| 8 pieces pedestal for cage-columns, 6984 lb. at 3 cents | 209 52 | |
| 24 columns of cage, 10 inches diameter, ¾-inch thick, 35,822 lb. at 3 cents | 1,704 66 | |
| 8 columns of cage, with oblique sleeves to receive heads of piles, 13,304 lb. at 3 cents | 399 12 | |
| 32 capitals of columns, 2400 lb. at 3 cents | 72 00 | |
| 8 pieces entablature for cage-columns, 21,435 lb. at 3 cents | 643 05 | |
| 32 ribs, dome of cage, 17,360 lb. at 3 cents | 520 80 | |
| 1 piece, base of cupola, 2664 lb. at 3 cents | 79 92 | |
| 8 columns of cupola, 1348 lb. at 3 cents | 40 44 | |
| 8 capitals of columns of cupola, 280 lb. at 3 cents | 8 40 | |
| 1 base-ring of cap, 1452 lb. at 3 cents | 43 56 | |
| 1 cap, 1100 lb. at 3 cents | 33 00 | |
| | | 3,150 49 |

*Labour on wrought-iron.—(ff).*

| | | |
|---|---|---|
| 16 diagonal braces (chord), welding, heading, cutting screws, &c., at $7 50 | 120 00 | |
| 32 turn-buckles for diagonal braces, forging, turning, cutting screws, &c., at $12 50 | 400 00 | |
| 8 diagonal braces (chord), welding, heading, cutting screws, &c., at $6 | 48 00 | |
| 16 turn-buckles for diagonal braces, forging, turning, cutting screws, &c., at $8 | 128 00 | |
| 1 pinnacle-rod, forging, &c. | 5 00 | |
| 4 bolt-rods in cupola, forging, &c. | 2 00 | |
| 4480 lb. bolt and bar iron, assorted sizes, for bolts, nuts, straps, &c., for section, at 4 cents | 179 20 | |
| | | 882 20 |

*Labour on cast-iron.—(gg).*

| | | |
|---|---|---|
| 16 diagonal brace clasps (chord), chipping, boring bolt-holes, &c., at $2 50 | 40 00 | |
| 8 pieces pedestal for cage-columns, chipping, boring bolt-holes, bolts, &c., at $2 50 | 20 00 | |
| 24 columns of cage, chipping, &c., at $2 50 | 60 00 | |
| 8 columns of cage, with oblique sleeves to receive heads of piles, chipping, boring bolt-holes, &c., at $8 50 | 68 00 | |
| 32 capitals of columns, chipping, &c., at 75 cents | 24 00 | |
| 8 pieces entablature for cage-columns, chipping, boring bolt-holes, bolts, &c., at $3 75 | 30 00 | |
| 32 ribs, dome of cage, chipping, boring bolt-holes, &c., at $2 | 64 00 | |
| 1 piece base of cupola, chipping, boring bolt-holes, &c. | 8 00 | |
| 8 columns of cupola, chipping, &c., at $1 25 | 10 00 | |
| 8 capitals of columns of cupola, chipping, &c., at 75 cents | 6 00 | |
| 1 base ring of cap, chipping, boring bolt-holes, bolts, &c. | 5 00 | |
| 1 cap, chipping, &c. | 4 00 | |
| | | 339 00 |

THIRD (DOUBLE) SECTION, LIGHT-HOUSE, NOT COMMON TO BEACON.

*Material—wrought-iron.—(hh).*

| | | |
|---|---|---|
| 24 spider-web braces (8 periphery, 8 radial, 8 chord), 5 by 3 inches, 13,535 lb. at 4 cents | 541 40 | |
| 32 diagonal braces (16 panel, 16 chord), 2-inch round iron 8663 lb. at 3½ cents | 303 20 | |
| 64 turn-buckles for diagonal braces, 1620 lb. at 4 cents | 64 80 | |
| 8 periphery collars for spider-web braces, 705 lb. each, at 6 cents, $42 30 each | 338 40 | |
| 8960 lb. bolt and bar iron, assorted sizes, for bolts, nuts, straps, &c., for section, at 4 cents | 358 40 | |
| | | 1,606 20 |

*Material—cast-iron.—(ii).*

| | | |
|---|---|---|
| 8 sleeves or couplings, 2478 lb. each, at 3 cents, $74 24 each | 594 72 | |
| 8 pockets for spider-web braces, 800 lb. at 3 cents | 24 00 | |
| 8 periphery collars for spider-web braces, 98 lb. each at 3 cents, $2 94 each | 23 52 | |
| 24 diagonal brace clasps (8 panel, 16 chord), 1296 lb. at 3 cents | 38 88 | |
| 8 spider-web brace clasps (chord), 2096 lb. at 3 cents | 62 88 | |
| 8 spider-web brace clasps (radial and chord), 1600 lb. at 3 cents | 48 00 | |
| | | 792 00 |

*Labour on wrought-iron.—(kk).*

| | | |
|---|---|---|
| 24 spider-web braces (8 periphery, 8 radial, 8 chord), forging, chipping, boring bolt-holes, &c., at $8 each all round | 192 00 | |
| 32 diagonal braces (16 panel, 16 chord), welding, heading, cutting screws, &c., at $6 | 192 00 | |
| 64 turn-buckles for diagonal braces, forging, turning, cutting screws, &c., at $8 | 512 00 | |

ESTIMATE FOR MATERIALS AND LABOUR—CONTINUED.

| | | |
|---|---|---|
| 8 periphery collars for spider-web braces, turning, chipping, boring bolt-holes, riveting bolts, &c., at $35 | $280 00 | |
| 8960 lb. bolt and bar iron, assorted sizes, for bolts, nuts, straps, &c., for section, at 4 cents | 358 40 | |
| | | $1,534 40 |

*Labour on iron.—(ll.)*

| | | |
|---|---|---|
| 8 sleeves or couplings, boring each 3 feet, 24 feet, at $6, $144; and turning for attaching collars, &c., at at $10, $80 | 224 00 | |
| 8 pockets for spider-web braces, chipping, boring bolt-holes, &c., at $2 50 | 20 00 | |
| 24 diagonal brace clasps (8 panel, 16 chord), chipping, boring bolt-holes, &c., at $2 50 | 60 00 | |
| 32 spider-web brace clasp (16 chorpd, 16 radial), chipping, boring bolt-holes, &c., at $3 | 96 00 | |
| | | 400 00 |

FOURTH (DOUBLE) SECTION, LIGHT-HOUSE NOT COMMON TO BEACON.

*Material—wought-iron—(mm).*

| | | |
|---|---|---|
| 8 periphery piles, from 8-inch tapering to 6-inch (hammered scrap), 5639 lb. each, at 9 cents, $507 51 each | 4,060 08 | |
| 24 spider-web braces (8 periphery, 8 radial, 8 chord), 5 by 3 inches, 9936 lb. at 4 cents | 397 44 | |
| 16 diagonal braces (chord) 2-inch round iron, 4756 lb. at 3½ cents | 166 46 | |
| 32 turn-buckles for diagonal braces, 810 lb. at 4 cents | 32 40 | |
| 16 diagonal braces (chord), 1½-inch round iron, 2198 lb. at 3½ cents | 76 93 | |
| 32 turn-buckles for diagonal braces, 810 lb. at 4 cents | 32 40 | |
| 8 periphery collars for spider-web braces, 705 lb. each. at 6 cents, $42 30 each | 338 40 | |
| 8 perpendicular and 8 horizontal bars in eave of entablature, 1538 lb. at 4 cents | 61 52 | |
| 245 square feet of 5-16 boiler iron to face entablature, 3084 lb. at 4½ cents | 138 78 | |
| 4480 lb. bolt and bar iron, assorted sizes, for bolts, nuts, straps, &c., for section, at 4 cents | 179 20 | |
| | | 5,483 61 |

*Material—cast-iron.—(nn).*

| | | |
|---|---|---|
| 1 cylinder, with pockets to receive heads of piles, 20,269 lb. at 2½ cents | 506 72 | |
| 8 pockets for spider-web braces, 800 lb. at 3 cents | 24 00 | |
| 8 periphery collars for spider-web braces 98 lb. each, at 3 cents, $2 94 each | 23 52 | |
| 8 capitals of piles, 960 lb. at 3 cents | 28 80 | |
| 8 pieces cornice (floor of watch-room), 3030 lb. at 3 cents | 90 90 | |
| 16 brackets, 806 lb. at 3 cents | 24 18 | |
| 8 gallery floor-plates, 1459 lb. at 3 cents | 43 77 | |
| 32 diagonal brace clasps, (chord), 1728 lb. at 3 cents | 51 84 | |
| 8 spider-web brace clasps (chord), 2096 lb. at 3 cents | 62 88 | |
| 8 spider-web brace clasps (radial and chord), 1600 lb. at 3 cents | 48 00 | |
| | | 904 61 |

*Labour on wrought-iron.—(oo).*

| | | |
|---|---|---|
| 8 periphery piles, from 8-inch tapering to 6-inch (hammered scrap), turning each 3 feet, 24 feet, at $6, $144; and turning to length, slot, and chipping, at $10, $80 | 224 00 | |
| 24 spider-web braces (8 periphery, 8 radial, 8 chord), forging, chipping, boring bolt-holes, &c., at $8 each all round | 192 00 | |
| 16 diagonal braces (chord), welding, heading, cutting screws, &c., at $6 | 96 00 | |
| 32 turn-buckles for diagonal braces, forging, turning, cutting screws, &c., at $8 | 256 00 | |
| 16 diagonal braces (chord), welding, heading, cutting screws, &c., at $6 | 80 00 | |
| 32 turn-buckles for diagonal braces, forging, turning, cutting screws, &c., at $5 | 160 00 | |
| 8 periphery collars for spider-web braces, turning, chipping, boring bolt-holes, rivetting boits, &c., at $35 | 280 00 | |
| 8 perpendicular and 8 horizontal bars in eave of entablature, forging, boring bolt-holes, cutting screws, at $2 50 | 40 00 | |
| 245 square feet 5-16 boiler iron to face entablature, bending, punching, riveting, &c. | 123 36 | |
| 4480 lb. bolt and bar iron, assorted sizes, for bolts, nuts, straps, &c., for section, at 4 cents | 179 20 | |
| | | 1,630 56 |

*Labour on cast-iron.—(pp).*

| | | |
|---|---|---|
| 1 cylinder, with pockets to receive heads of piles, boring 12 feet of pockets, at $6, $72; chipping, &c., $60 | 132 00 | |
| 8 pockets for spider-web braces, chipping, boring bolt-holes, &c., at $2 50 | 20 00 | |
| 8 periphery collars for spider-web braces, planing, &c., at $8 | 64 00 | |
| 8 capitals of piles, chipping, &c., at $3 | 24 00 | |
| 8 pieces cornice (floor of watch-room), chipping, &c., at $2 | 16 00 | |
| 16 brackets, chipping, boring bolt-holes, &c., at $2 | 32 00 | |
| 8 gallery floor-plates, chipping, boring bolt-holes &c., at $2 50 | 20 00 | |
| 32 diagonal brace clasps (chord), chipping, &c., at $2 50 | 80 00 | |
| 16 spider-web brace clasps (8 chord, 8 radial), chipping, boring bolt-holes, &c., at $3 | 48 00 | |
| | | 436 00 |

DWELLING, &c., FROM THIRD (DOUBLE) SECTION, INCLUSIVE, LIGHT-HOUSE, NOT COMMON TO BEACON.

*Material—wrought-iron.—(qq).*

| | | |
|---|---|---|
| 1946 square feet 5-16 boiler-iron for walls of 1st and 2nd stories of dwelling (30 feet in diameter), 24,496 lb. at 4½ cents | 1,102 32 | |
| 565 square feet 5-16 boiler-iron for walls of 3rd story of dwelling (20 feet in diameter), 7112 lb. at 4½ cents | 320 04 | |
| 1591 square feet 5-16 boiler-iron for cylinder, from roof of dwelling to base of watch-room (8 feet in diameter), 20,028 lb. at 4½ cents | 901 26 | |

ESTIMATE FOR MATERIALS AND LABOUR—CONTINUED.

| | | |
|---|---|---|
| 371 square feet 5-16 boiler-iron for walls of watch-room (12 ft. 3 in. in diameter), 4670 lb. at 4½ cents .. | $210 15 | |
| 204 square feet 5-16 boiler-iron for roof of lantern, 2568 lb. at 4½ cents .. .. .. .. .. .. | 115 56 | |
| 16,688 rivets for the above boiler-iron work, 4172 lb. at 4 cents .. .. .. .. .. .. .. | 166 88 | |
| 8 lower floor beams of dwelling, 4 by 3-inch, 7142 lb. at 4 cents .. .. .. .. .. .. .. .. | 285 68 | |
| 13 second-floor beams of dwelling, 4 by 2-inch, and 1 truss beam, 4 by 3-inch, 8012 lb at 4 cents .. .. .. | 320 48 | |
| 8 third-floor beams of dwelling, 3 by 3-inch and 1 semi-circular ring, 4 by 1-inch, 2276 lb. at 4 cents .. | 91 04 | |
| 16 roof-beams of dwelling, 3 by 3-inch, and circular ring, 4 by 1-inch, 3702 lb. at 4 cents .. .. .. .. | 148 08 | |
| 16 bracket-bars for lower gallery of dwelling, 3 by 3-inch, 2913 lb. at 4 cents .. .. .. .. .. .. | 116 52 | |
| 24 wall-bars of dwelling, 885 lb. at 3½ cents .. .. | 35 40 | |
| 192 feet 1¼-inch round iron for hand-rail stairs of cylinder, 801 lb. at 3½ cents .. .. .. .. .. .. | 28 03 | |
| 1 foot-ring outside of lantern, 544 lb. at 4½ cents .. | 24 48 | |
| 96 oblique sash-bars of lantern, 1861 lb. at 6 cents .. | 111 66 | |
| 1 ring and 32 horizontal sash-tops of lantern, 784 lb. at 6 cents .. .. .. .. .. .. .. | 47 04 | |
| 1 hand and 1 foot-ring outside of lantern, 218 lb. at 3½ cents .. .. .. .. .. .. .. .. | 7 63 | |
| 1 pinnacle, 25 lb. at 3½ cents .. .. .. .. .. | 87 | |
| 1453 lb. bar and round iron for boat-hoisting apparatus, davits, &c., at 4½ cents . .. .. .. .. .. | 65 38 | |
| 850 lb. iron for hoisting apparatus for stores, frames, carriage, &c., at 4½ cents .. . .. .. .. .. | 38 25 | |
| 328 feet 5-16 chain for boat-hoisting apparatus, at 12½c. | 41 00 | |
| 200 feet 3-16 chain for hoisting apparatus for stores, at 12½ cents .. .. .. .. .. .. .. .. | 25 00 | |
| 400 lb. iron for gearing, common to both hoisting apparatus, at 4 cents .. .. .. .. .. .. .. | 16 00 | |
| 6720 lb. bolt and bar iron, assorted sizes, for bolts, nuts, straps, &c. for section, at 4 cents .. .. .. .. | 268 80 | |
| | | $4,487 55 |
| *Material—cast-iron.—(rr).* | | |
| 1 centre hollow pile from base of dwelling to base of watch-room, 8253 lb. at 3 cents .. .. .. .. | 247 59 | |
| 24 ½-inch floor-plates, for lower story of dwelling, 13,232 lb. at 3 cents .. .. .. .. .. .. .. .. | 396 96 | |
| 16 ½-inch floor-plates for lower gallery of dwelling, 6 feet wide, with lip, 25,171 lb. at 3 cents .. .. .. | 755 13 | |
| 16 ½-inch floor-plates for upper gallery of dwelling, 6 feet 5 inches wide, with lip, 15,879 lb. at 3 cents .. .. | 476 37 | |
| 16 ½-inch roof-plates of dwelling, 9845 lb. at 3 cents .. | 295 35 | |
| 4 landing-plates of stairs in cylinder, 2779 lb. at 3 cents | 83 37 | |
| 1 ½-inch floor-plate of watch-room, 521 lb. at 3 cents .. | 15 63 | |
| 8 pieces cornice at second story of dwelling, 6816 lb. at 3 cents .. .. .. .. .. .. .. .. | 204 48 | |
| 8 pieces cornice at roof of dwelling, 1771 lb. at 3 cents .. | 53 13 | |
| Railing of lower gallery of dwelling, 8614 lb. at 3 cents .. | 258 42 | |
| Railing of upper gallery of dwelling, 5216 lb. at 3 cents .. | 156 48 | |
| Railing of roof of dwelling, 2092 lb. at 3 cents .. .. | 62 76 | |
| Railing of watch-room, 3937 lb. at 3 cents .. .. | 118 11 | |
| 24 brackets, cornice of second story of dwelling, 780 lb. at 3 cents .. .. .. .. .. .. .. .. | 23 40 | |
| 32 brackets, cornice of roof of dwelling, 774 lb. at 3 cents | 23 22 | |
| 4 sash-door frames, lower story of dwelling, 1441 lb. at 3c. | 43 23 | |
| 8 window-frames, second story of dwelling, 2992 lb. at 3c. | 68 76 | |
| 3 window and 1 sash-door frames of third story of dwelling 855 lb. at 3 cents .. .. .. .. .. .. | 25 65 | |
| 8 window frames in cylinder, 880 lb. at 3 cents .. .. | 26 40 | |
| 1 door and door-frame in cylinder, top of dwelling, 415 lb. at 3 cents .. .. .. .. .. .. .. | 12 45 | |
| 1 door and door-frame in cylinder, watch-room gallery, 415 lb. at 3 cents .. .. .. .. .. .. .. | 12 45 | |
| 4 dead-eye holes frames and shutters in cylinder, 124 lb. at 3 cents .. .. .. .. .. .. .. | 3 72 | |
| 116 steps in cylinder, 9862 lb. at 3 cents .. .. .. | 295 86 | |
| 8 registers in watch-room, 200 lb. at 3 cents .. .. | 6 00 | |
| 8 exterior and 8 interior brackets, watch-room and lantern, 693 lb. at 3 cents .. .. .. .. .. .. | 20 79 | |
| Base ring of lantern, 1089 lb. at 3 cents .. .. .. .. | 32 67 | |
| Top ring of lantern, 1890 lb. at 3 cents .. .. . | 56 70 | |
| 8 floor-plates of lantern, 1059 lb. at 3 cents .. .. | 31 77 | |
| 8 floor-plates of gallery of lantern, 4293 lb. at 3 cents .. | 128 79 | |
| 1 smoke-flue of lantern, 413 lb. at 3 cents .. .. | 12 39 | |
| 1 base ring of dome of lantern, 385 lb. at 3 cents .. . | 11 55 | |
| 1 ventilator of dome of lantern, 245 lb. at 3 cents .. | 7 35 | |
| Cornice of dome of lantern, 299 lb. at 3 cents .. .. | 8 87 | |
| Cap of dome of lantern, 439 lb. at 3 cents .. .. | 13 17 | |
| 249 lb. 4 boxes and 1 clasp, boat-hoisting apparatus, at 3c. | 7 47 | |
| 180 lb. hoisting apparatus for stores, drum, frame, &c., at 3 cents .. .. .. .. .. .. .. .. | 5 40 | |
| 1200 lb. gearing for apparatus for stores, drum, frame, &c. at 3 cents .. .. .. .. .. .. .. | 36 00 | |
| | | 4,035 84 |
| *Labour on wrought-iron.—(ss).* | | |
| 1946 square feet 3-16 boiler-iron for walls of first and second stories of dwelling, cutting, punching, fitting, riveting, &c., at 50 cents .. .. .. .. .. | 937 00 | |
| 565 square feet 5-16 boiler-iron for walls of third story of dwelling, cutting, punching, fitting, riveting, &c., at 50 cents .. .. .. .. .. .. .. | 282 50 | |
| 1591 square feet 5-16 boiler-iron for cylinder from roof of dwelling to base of watch-room, cutting, punching, fitting, riveting, &c., at 50 cents .. .. .. .. | 795 50 | |
| 371 square feet 5-16 boiler-iron for walls of watch-room, cutting, punching, fitting, riveting, &c., at 50 cents .. | 185 50 | |
| 204 square feet 5-16 boiler-iron for roof of lantern, cutting, punching, fitting, riveting, &c., at 50 cents .. .. | 102 00 | |
| 16,688 rivets for the above boiler-iron work, forging, &c., at 4 cents .. .. .. .. .. .. .. | 667 52 | |
| 8 lower-floor beams of dwelling, forging, chipping, boring bolt-holes, &c., at $5 .. .. .. .. .. | $40 00 | |
| 13 second-floor beams and 1 truss beam of dwelling, forging, chipping, boring bolt-holes, &c., at $8 .. | 112 00 | |
| 8 third-floor beams and 1 semicircular ring of dwelling, forging, chipping, boring bolt-holes, &c., at $7 .. .. | 63 00 | |
| 16 roof-beams, and 1 circular ring of dwelling, forging, chipping, boring bolt-holes, &c., at $5 .. .. | 85 00 | |
| 16 bracket-bars for lower gallery of dwelling, forging, chipping, boring bolt-holes, &c., at $5 .. .. .. | 80 00 | |
| 24 wall-bars of dwelling, forging, chipping, boring bolt-holes, &c., at $7 .. .. .. .. .. .. | 168 00 | |
| 192 ft. 1¼ in. hand-rail of stairs in cylinder, bending, &c., at 40 cents .. .. .. .. .. .. .. | 76 80 | |
| 1 foot-ring outside of lantern, turned, drilled, chipped, &c. | 70 00 | |
| 96 oblique sash-bars of lantern, forging, &c., at $4 .. | 384 00 | |
| 1 ring and 32 horizontal sash-stops of lantern; ring, $40; stops, $1 32 each .. . .. .. .. .. | 82 24 | |
| 1 hand and 1 foot ring outside of lantern, 85 feet bending, &c., at 40 cents .. .. .. .. .. .. .. | 34 00 | |
| 1 pinnacle, forging, &c. .. .. .. .. .. .. .. | 4 00 | |
| 1453 lb. bar and round iron for boat-hoisting apparatus, davits, &c. .. .. .. .. .. .. .. .. | 125 00 | |
| 850 lb. iron for hoisting apparatus for stores, frame carriage, &c. .. .. .. .. .. .. .. .. | 75 00 | |
| 400 lb. iron for gearing, common to both apparatuses .. | 34 00 | |
| 6720 lb. bolt and bar iron, assorted sizes, at 4 cents | 268 80 | |
| | | $4,707 86 |
| *Labour on cast iron.—(tt).* | | |
| 1 centre hollow pile from base of dwelling to base of watch-room, drilling, chipping, &c., 5 pieces, at $5 .. | 25 00 | |
| 24 ½-inch floor-plates, lower story of dwelling, drilling, chipping, &c., at $3 .. .. .. .. .. .. | 72 00 | |
| 16 ½-inch floor-plates, lower gallery of dwelling, drilling, chipping, &c., at $8 .. .. .. .. .. .. | 128 00 | |
| 16 ½-inch floor-plates, upper gallery of dwelling, drilling, chipping, &c., at $10 .. .. . .. | 160 00 | |
| 16 ⅜-inch roof-plates of dwelling, drilling, chipping, &c., at $8 .. .. .. .. .. .. .. .. | 128 00 | |
| 4 ⅜-inch landing-plates of stairs in cylinder, drilling, chipping, &c., at $6 .. .. .. .. .. .. | 24 00 | |
| 1 ½-inch floor-plate of watch-room, drilling, chipping, &c. | 6 00 | |
| 8 pieces of cornice, second story of dwelling, drilling, chipping, &c., at $12 .. .. .. .. | 96 00 | |
| 8 pieces cornice, roof of dwelling, drilling, chipping, &c., at $8 .. .. .. .. .. .. .. .. | 64 00 | |
| Railing, lower gallery of dwelling, drilling, chipping, &c., 138 feet, at $1 .. .. .. .. .. .. .. | 138 00 | |
| Railing, upper gallery of dwelling, drilling, chipping, &c., 104 feet, at $1 .. .. .. .. .. .. .. | 104 00 | |
| Railing, roof of dwelling, drilling, chipping, &c., 66 feet, at $1 .. .. .. .. .. .. .. .. | 66 00 | |
| Railing, watch-room, drilling, chipping, &c., 8 pieces, at $12 .. .. .. .. .. .. .. .. | 96 00 | |
| 24 brackets, cornice second story of dwelling, drilling, chipping, &c., at $3 .. .. .. .. .. .. | 72 00 | |
| 32 brackets, cornice of roof of dwelling, drilling, chipping, &c., at $3 .. .. .. .. .. .. | 96 00 | |
| 4 sash-door frames, lower story of dwelling, drilling, chipping, &c., at $12 .. .. .. .. .. | 48 00 | |
| 8 window-frames, second story of dwelling, drilling, chipping, &c., at $12 .. .. .. .. .. .. | 96 00 | |
| 3 window and 1 sash-door frame, third story of dwelling, drilling, chipping, &c., $12 .. .. .. .. .. .. | 48 00 | |
| 8 window-frames in cylinder, drilling, chipping, &c., at $6 | 48 00 | |
| 1 door and 1 door-frame in cylinder, top of dwelling, drilling, chipping, &c. .. .. .. .. .. | 35 00 | |
| 1 door and 1 door-frame, watch-room, drilling, chipping, &c. .. .. .. .. .. .. .. .. | 35 00 | |
| 4 dead-eye hole frames and shutters, drilling, chipping, &c., at $9 .. .. .. .. .. .. .. | 36 00 | |
| 116 steps in cylinder, drilling, chipping, &c. at 75 cents | 87 00 | |
| 8 registers in watch-room, drilling, chipping, &c., at $6 | 48 00 | |
| 8 exterior and 8 interior brackets, watch-room and lantern drilling, chipping, &c., at $3 .. .. .. .. | 48 00 | |
| Base ring of lantern, drilling, chipping, &c. .. .. .. | 15 00 | |
| Top ring of lantern, drilling, chipping, &c. .. .. | 25 00 | |
| 8 floor-plates of lantern, drilling, chipping, &c., at $3 .. | 24 00 | |
| 8 floor-plates, gallery of lantern, drilling, &c., at $8 .. | 64 00 | |
| 1 smoke-flue of lantern, drilling, chipping, &c. .. .. | 8 00 | |
| 1 base-ring, dome of lantern, drilling, chipping, &c. .. | 6 00 | |
| 1 ventilator do. do. .. .. .. .. | 5 00 | |
| Cornice do. do. .. .. .. | 5 00 | |
| Cap do. do. .. .. .. .. | 5 00 | |
| 249 lb. 4 boxes and 1 clasp, boat hoisting apparatus, drilling, chipping, &c. .. .. .. .. .. .. | 25 00 | |
| 180 lb. hoisting apparatus for stores, drum, frame, &c., drilling, chipping, &c. .. .. .. .. .. .. | 12 00 | |
| 1200 lb. gearing, common to both hoisting apparatuses, drilling, chipping, &c. .. .. .. .. .. | 105 00 | |
| | | 2,098 00 |

## *Estimate for patterns (b).*

| LIGHT-HOUSE, NOT COMMON TO BEACON. | | |
|---|---|---|
| Centre hollow pile .. .. .. .. .. .. | 21 60 | |
| Floor-plates in first story of dwelling (two patterns) .. | 35 20 | |
| Floor-plates in first gallery .. .. .. .. .. | 24 30 | |
| Floor-plates in upper gallery .. .. .. .. | 16 20 | |
| Floor-plates of dwelling .. .. .. .. .. .. | 14 25 | |
| Landing-plates in cylinder .. .. .. .. .. | 13 50 | |
| Landing-plates in watch-room .. .. .. .. .. | 8 60 | |
| Facia and flaucier of cornice of second story of dwelling | 22 96 | |

ESTIMATE FOR PATTERNS—CONTINUED.

| | | |
|---|---|---|
| Facia and faucier of cornice of third story of dwelling | $10 80 | |
| Cornice and entablature | 20 25 | |
| Third series of sleeves or couplings | 22 95 | |
| Socket-cap of piling | 74 25 | |
| Dead-eye lights in cylinder | 10 80 | |
| Base ring of lantern | 21 60 | |
| Top ring of lantern | 24 30 | |
| Railing around watch-room | 37 80 | |
| Gallery floor-plates around watch-room | 16 20 | |
| Pile-capitals under entablature | 16 50 | |
| Smoke-flue in lantern | 13 50 | |
| Cap-ring in base of dome | 16 20 | |
| Ventilators in cupola | 18 90 | |
| Cornice in cupola | 16 20 | |
| Cap of cupola | 13 50 | |
| Brackets for lantern | 9 50 | |
| Registers in watch-room | 13 50 | |
| Brackets in entablature | 19 60 | |
| Brackets in cornice, second story | 17 75 | |
| Brackets in cornice, third story | 18 90 | |
| Railing of first gallery | 16 87 | |
| Railing of second gallery (part of first story used for this) | 8 50 | |
| Railing of roof | 11 50 | |
| Steps in cylinder | 18 90 | |
| Window and door frames | 38 80 | |
| Pocket for spider-web braces | 6 25 | |
| Cast-iron block | 2 36 | |
| Gallery-plate around lantern | 16 87 | |
| Interior plate around lantern gallery | 10 25 | |
| Clasp for spider-web bracing (chord) | 13 50 | |
| Clasp for spider-web bracing (radial) | 10 80 | |
| Clasp for diagonal braces | 10 80 | |
| Total amount | | $729 90 |

LIGHT-HOUSE, COMMON TO BEACON.

| | | |
|---|---|---|
| Cylinder with cone | 52 65 | |
| Centre collar at top of pile | 25 00 | |
| Sleeves or couplings at angle | 25 65 | |
| Second series of sleeves or couplings | 24 30 | |
| Piping from cone to receiver | 23 30 | |
| Receivers | 44 60 | |
| Supports for receivers | 14 85 | |
| Heads to receivers | 6 65 | |
| Collars | 1 75 | |
| Clasps (radial), for spider-web braces | 10 80 | |
| Clasps (chord), do. | 13 50 | |
| Clasps (chord), diagonal for spider-web braces, to clasp 3 | 16 25 | |
| Clasps (radial). diagonal for spider-web braces, to clasp 2 | 10 80 | |
| Total amount | | 270 10 |

ESTIMATE FOR PATTERNS—CONTINUED.

BEACON, NOT COMMON TO LIGHT-HOUSE.

| | | |
|---|---|---|
| Pedestal for cage | $16 75 | |
| Columns for cage | 25 65 | |
| Capitals of columns | 16 20 | |
| Entablature frame | 21 50 | |
| O. G. rafter | 16 20 | |
| Base of cupola | 27 00 | |
| Columns of cupola | 11 45 | |
| Capitals of columns | 13 50 | |
| Facia and soffit | 2 00 | |
| Cap of cupola | 4 65 | |
| Total amount | | $154 90 |

*Pneumatic Apparatus, common to both Light-house and Beacon* (*f*)

| | | |
|---|---|---|
| *Material—wrought-iron.* | | |
| 9 air-pipes (270 feet), from soil-receivers to exhausted-receiver, at 12 cents | $32 40 | |
| 9 straps for supporting soil-receivers, 1172 lb. at 3½ cents | 41 02 | |
| | | $73 42 |
| *Material—cast-iron.* | | |
| 9 soil-pipes to cones, 1654 lb. each, at 3 cents, $49 62 each | 446 58 | |
| 8 clasps for support of soil-receivers, 483 lb. each, at 3c. $14 49 each | 115 92 | |
| 1 clasp for support of centre receivers, 194 lb. at 3 cents | 5 82 | |
| 9 soil-receivers, 5157 lb. each, at 3 cents. $154 71 each | 1,392 39 | |
| 18 soil-receiver heads, 87 lb. each, at 3 cents, $2 61 each | 46 98 | |
| 1 exhausted-receiver, 5157 lb. at 3 cents | 154 71 | |
| 2 exhausted-receiver heads, 87 lb. each, at 3c. $2 61 each | 5 22 | |
| 2 clasps for centre soil-pipe, 290 lb. at 3 cents | 8 70 | |
| | | 2,176 32 |
| *Labour on wrought-iron.* | | |
| 9 air-pipes (270 feet), from soil-receivers to exhausted receiver, at $5 | 45 00 | |
| 9 straps for supporting soil-receivers, at $2 | 18 00 | |
| | | 63 00 |
| *Labour on cast-iron.* | | |
| 9 soil-pipes to cones, chipping, cutting screws, &c., at $15 | 135 00 | |
| 8 clasps for support of soil-receivers, chipping, boring bolt-holes, &c., at $8 | 64 00 | |
| 9 soil-reservoirs, turning off ends, fitting hinge joints to outlets, head for top and piping, &c., at $25 each | 225 00 | |
| 18 soil-receiver outlets and heads, turning, &c., at $5 | 90 00 | |
| 1 exhausted-receiver, turning off ends, fitting heads, seats for air-pump, and connecting air-pipes | 30 00 | |
| 2 exhausted-receiver heads, turning, &c., at $5 | 10 00 | |
| 2 clasps for centre soil-pipes, turning, &c., at $9 | 18 00 | |
| | | 572 00 |
| 1 small steam-engine for working the pneumatic apparatus | | 1,200 00 |
| Total amount | | 4,084 74 |

*Statement of the exposure, distance from land and nearest harbour, nature and height or depression of the bottom, rise and fall of the tide, and velocity of the current, at Eddystone, Bell Rock, Skerryvore, and New South Shoal; also the cost and length of time required to erect the light-houses at the three points first named, and the estimated cost and probable length of time required to erect the proposed lighthouse at New South Shoal.*

| Position. | Exposure. | | | | Distance from land. | Distance from nearest harbour. | Nature of the bottom | Height or depression of bottom, compared with low water. | | Rise and fall of the tide. | Velocity of the current. | Cost. | Length of time erecting. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Towards the sea. | | Towards the land. | | | | | | | | | | |
| | Arc. | Distance. | Arc. | Distance. | | | | Above. | Below. | | | | |
| | Deg. | | Deg. | Miles. | Miles. | Miles. | | Feet. | Feet. | Feet. | Miles. | | Years. |
| Eddystone ...... | 166 | English channel and Atlantic | 194 | 9½ to 44 | 9½ | 13½ | Rock ... | 12 | ......... | 18 | Not known | *$189,000 | 4 |
| Bell Rock ...... | 140 | North sea or German ocean | 220 | 13½ to 77 | 13½ | 15 | Rock ... | 4 | ......... | 16 | Not known | †306,657 | 4 |
| Skerryvore ...... | 133 | Atlantic ocean | 227 | 10½ to 103 | 10½ | 10½ | Rock ... | 17 | ......... | 12½ | 2½ to 4½ | ‡449,086 | 6 |
| N. South Shoal | 270 | Atlantic ocean | 90 | 20 to 103 | 20 | 42 | Hard sand | ......... | 8 | 4 | 1½ to 2½ | §322,787 | §3 |

* £37,800. † £61,331 9s. 2d. ‡ £89,817 6s. 11d. § Estimated.

*Eddystone.*—1756 to 1759 inclusive. The mean height of the rock above low water is given. Light first exhibited 16th of October, 1759.

*Bell Rock.*—1807 to 1810 inclusive. Light first exhibited 1st of February, 1811.

*Skerryvore.*—1838 to 1843 inclusive. Light first exhibited 1st of February, 1844; surveys, 1834 and 1835; opening quarries, &c., 1836 and 1837. The nearest harbour is Hynish bay, which being open through a large arc, others about the islands of Coll and Mull, in some instances forty miles distant, were used. Two thousand tons of stone were cut off the rock before building.

*New South Shoal.*—One year and a half in addition in the preparation of the structure. Nantucket is forty miles distant; but this harbour would not always be available, from the limited depth at the entrance (six and a half feet) at low water.

OFFICE OF NEW SOUTH SHOAL BEACON,
*Philadelphia, Dec* 27, 1851.

HARTMAN BACHE,
*Major Topographical Engineers, Brevet Major.*

## INSTITUTION OF CIVIL ENGINEERS.

SUBJECTS FOR PREMIUMS—*Session* 1854-55.

The Council invite communications on the following, as well as other subjects, for Premiums; and which are to be forwarded to the Institution on or before January 30, 1855:—

1. On the principles upon which the works for the improvement of river navigation should conducted, and the effects of the works upon the drainage and irrigation of the district.

2. The construction, improvement, and maintenance of natural or artificial harbours and docks, with the forms and action of large sluices, for clearing away deposits by the use of backwater, or by directing the natural currents.

3. The selection of sites for the construction of docks on the course of tidal streams, with reference to communication with railways and with inland navigation.

4. The selection of sites for, and the principles of, the construction of breakwaters and of harbours of refuge, illustrated by examples of existing works.

5. The forms and construction of piers, moles, or breakwaters (whether solid or on arches), sea-walls, and shore defences, illustrated by examples of known constructions, such as the Cobb-wall at Lyme Regis, &c.

6. On the chemical constitution, the method of preparation and the use of artificial cements, to be employed either as "beton") for forming foundations under water or on dry land, and for stuccoing the exterior of houses.

7. The best system of forming artificial foundations, showing the ratio of pressure to surface, and the soil best calculated to sustain heavy structures, illustrated by the best examples in modern practice, and by accounts of the failure of large works.

8. The history and practical results of timber and iron piling for foundations and for wharf and dock walls, with notices of mechanical modes of driving.

9. The relative value of various kinds of natural stone available in Great Britain for the purposes of construction, with experiments on the law of increase of the crushing force of short blocks of stone, with their diameters.

10. On brick and tile-making, and the capability of introducing new forms for engineering and architectural purposes, with the processes most useful to emigrants and settlers.

11. The laws of the strength of cast and wrought iron under the various conditions of tensile, compressive, transverse, tortional, impulsive, and other strains, with examples illustrative of the coefficients employed by eminent practical authorities in the construction of works.

12. The forms and dimensions of journals of machine-shafts, axles, &c., with the best composition for the linings of bearings, and the most approved methods of lubricating.

13. The construction of girder-bridges, whether of trussed timber or wooden lattice; of cast-iron trussed or plain, or combined with wrought-iron in simple or compound triangulation; of wrought-iron lattice-work; or of plate-iron riveted sides with cellular top and bottom.

14. The construction of suspension-bridges with rigid platforms, and the modes of anchoring the stay-chains.

15. The comparative advantages of iron and wood, or of both materials combined, for the construction of steam-vessels, with drawings and descriptions; the methods for preventing corrosion; and details of the arrangement for the compasses, and for their adjustment in iron ships.

16. On the changes that have been introduced within the last fifteen years in the lines of ships and steam-vessels; and an examination of the effects produced by the new law of measurement for tonnage.

17. An examination of the circumstances which appear to limit the maintenance of higher speeds than are now attained by steam-ships in deep-sea navigation; and an inquiry into the causes which have hitherto prevented the asserted high speeds of steam navigation on the American rivers from being arrived at in England.

18. The results of the use of tubular boilers, and of steam at increased pressure, for marine and other engines, noticing particularly the difference between weight and speed in proportion to the horse-power and the tonnage; with details of the most successful means for avoiding smoke in furnaces of all descriptions.

19. The best methods of reducing the temperature of the engine and boiler room of steam-vessels, and of preventing the danger arising from the over-heating of the base of the funnel.

20. The relative efficiency of the screw-propeller and paddle-wheels when applied to vessels of identical form, tonnage, and steam-power, independent of the use of sails.

21. The results of the application of steam-power and screw-propellers to the conveyance of coal, compared with the system of sailing-vessels.

22. The arrangement and distribution of the workshops at the principal repairing-station of a railway, for the repairs and maintenance of the locomotives, passenger, and other carriages, &c., derived from existing examples.

23. The construction of locomotive engines, specially adapted for steep inclines, with accounts of experiments demonstrating the comparative value of large and small engines under various circumstances.

24. Improvements in the manufacture of iron for rails and wheel-tyres, having special reference to the increased capability of resisting lamination and abrasion.

25. On the cost of maintenance of the permanent way, noticing the principal systems in use for the last ten years, and the depreciation of the rolling stock of railways.

26. Improvements in the construction of railway carriages and wagons, with a view to the reduction of the gross weight of passenger trains, also of railway wheels, axles, bearings, and breaks, treating particularly their ascertained duration and their relative friction.

27. The results of a series of observations on the flow of water from the ground, in any large districts, with accurately recorded rain gauge registries in the same locality for a period not less than twelve months.

28. On the construction of catch-water reservoirs in mountain districts, for the supply of towns, or for manufacturing purposes.

29. The laws governing the velocity and discharge of currents of water, whether in pipes or in open channels, receiving tributary accessions at various points of their course.

30. The comparative duty performed by the various descriptions of steam engines for raising water for the supply of towns, or for the drainage of mines; noticing the depth and length of the underground workings, the height of the surface above the sea, the geological formation, the contiguity of streams, &c.

31. The drainage and sewerage of large towns, exemplified by accounts of the systems at present pursued with regard to the level and position of the outfall; the form, dimensions, and material of the sewers, the prevention of emanations from them, the disposal of the sewage, whether in a liquid or solid form, and of the arrangements for connecting the house drains with the public sewers.

32. The precautions adopted for guarding against accidents by fire-damp in mines.

33. The results of contrivances for facilitating the driving of tunnels or drifts in rock.

34. Descriptions of various kinds of machinery in use in the principal shipping ports, for the shipment of coal, noticing particularly those in which the greatest expedition is combined with the least amount of breakage of the coal, and also accounts of the means of unshipping, and measuring, or weighing the coal on its arrival in port.

35. Descriptions of the ovens, and of the best processes used in Great Britain and on the continent in the manufacture of coke for railway and other purposes, with the comparative values of the products.

36. Improvements in the system of lighting by gas; the results of the use of clay-retorts; of large ovens (for producing a better quality of coke); of exhausters, condensers, and modes of purifying, and the precautions for the economical distribution of gas.

37. A mathematical or geometrical demonstration of the advantages of flat sails for ships over those of different degrees of curvature, when exposed to direct and slanting winds, with practical examples.

38. On the application of machinery combined with mechanical power, and the means of transporting manure and produce on large farms and agricultural establishments; and on improvements in the plan of the works and buildings and the "plant" employed.

39. The most effective arrangement and form of centrifugal and reciprocating blowing apparatus.

40. The chemical analysis and the application to economic purposes of the gases generated in iron blast furnaces.

41. An investigation of the causes of "red" and of "cold-shortness" in malleable iron, and other chemical characteristics which affect the physical properties of cast or of wrought iron.

42. Description of cast or wrought iron cranes, scaffolding, and machinery employed in large works, in stone quarries, hoists or lifts on quays, in warehouses, &c., especially where either steam or water is used as a motive power.

43. On the improvements which may be effected in the buildings, machinery, and apparatus for producing sugar from the cane in the plantations and sugar works of the British colonies, and the comparison with beet-root with regard to quantity, quality, and economy of manufacture.

44. Accounts of the improved systems of storing corn, and of producing flour.

45. Description of the machinery adapted for the preparation of Indian cotton.

46. Improvements in flax machinery, and in the processes for preparing the flax for manipulation.

47. Notice of the principal self-acting tools employed in the manufacture of engines and machines; also of moulding-machines and wood-working machines, and the effect of their introduction.

48. The construction of lighthouses, their machinery and lighting apparatus, with notices of the methods in use for distinguishing the different lights.

49. Memoirs and accounts of the works and inventions of any of the following engineers:—Sir Hugh Middleton, Arthur Woolf, Jonathan Hornblower, Richard Trevithick, William Murdoch (of Soho), and Alexander Nimmo.

## THE DISTINCTION BETWEEN ILLUMINATION AND PAINTING.

### MR. RUSKIN'S LECTURES ON DECORATIVE COLOUR AT THE ARCHITECTURAL MUSEUM.

MR. RUSKIN commenced by stating that he was not going to read a paper or to speak from notes, and it was a mistake in the advertisement to say that he intended to deliver a lecture. It was not a lecture, but a talk; and his object was to address himself to the students present, and place before them, in a familiar way, things which were useful.

Before entering upon his subject, however, he wished to glance at one or two historical points, with the view of explaining the examples he proposed to set before them. In these days it was a very common practice to laugh at the middle ages, and hold them up to ridicule. Truly, they were ridiculous in many senses, but certainly they were not ridiculous in their way of writing. They did not write in those days so much as we do now, but they wrote much better when they did write. Even so far back as the seventh century, the Saxon writing began to acquire character and dignity, though the writing of that period differed materially from anything that we did now. The specimen he now submitted (an initial letter) was written as an ornament to a psalter belonging to a lady who died in the year 656, St. Salaberga. It would be perceived that the colours employed in writing in that day were simply black, yellow, and red. The design in the example was a continuous scroll, beginning in a bird's beak, and terminating in a sort of yellow dragon. It never encountered itself at a turn, but it glanced off and met again in some different part of its progress, and never doubled simply upon itself. Such was the general character of the MS. of that century. It was not very easy to imitate. He had himself tried it, but found it difficult, and to do it well considerable practice would be required. He wished, however, to draw attention to the fact, that there was a character and a finish about this writing which was not found in common penmanship.

From these yellow and black scrolls they went on improving until the time of Charlemagne, when the art of illuminated writing received a great impulse. Then more and more colour was introduced in the finish, and greater variety in the outline. It had been frequently said that Charlemagne could not write; true, he could not write in what would be called writing now, for what we now understand as writing would not have been called writing in the days of Charlemagne. Here was an example of the writing of that age. This (the specimen exhibited) was written in the eighth century, and it was the beginning of one of the books of the Gospel. It would be observed that more colour was introduced about this time; and they would notice how it was stolen in, as it were upon the gold. But though it was said Charlemagne could not write, though he could not write as we write now, yet he could write after a fashion. He always carried tablets about with him, upon which he from time to time put down anything he desired to remember. He could not, however, write like the specimen the meeting were now examining; but he employed those who could, and paid great respect to them. Immense respect was paid to to the writers of those days. He (the lecturer) would much like that respect paid to the art of writing now. As showing the kind of respect which this art commanded in the middle ages, he would read an anecdote respecting an eminent writer who lived in the time of Charlemagne. "There was in the monastery of Arnisberg a writer named Richard, an Englishman, who had with his own hand copied a great number of books, hoping to receive in heaven a recompence for his labours. When he quitted this life, his brother monks buried him in a place of honour. Twenty years afterwards his tomb was opened, and his right hand was found in as perfect a state of preservation as though it were alive, and appeared to have been recently cut off from an animated body, while all the rest of the corpse was dust. This hand is shown as a great miracle to this day in the monastery of Arnisberg." This showed the honour with which a good writer was regarded at that period; and not only was the art honourable and profitable to those who practised it, but its effect was profitable and valuable to others. We had an instance of this in the history of one to whom we were indebted for all our English literature—he alluded to King Alfred. Alfred himself was honoured in France for his writing; and the best writing of that period came from France. It was well known that the French princess Judith, who was Alfred's stepmother, took great pains to teach him; but it would seem that he had naturally no more taste for study than other children, for it was recorded of him that he lived to twelve years old before he was taught to read. How he was induced to learn was, according to Mr. Sharon Turner, in this wise. "When Alfred was twelve years old, she [Judith] was sitting one day surrounded by her family with a MS. of Saxon poetry in her hands. With a happy judgment she proposed it as a gift to him who would the soonest learn to read it. The whole incident may have been chance play, but it was fruitful of consequences. The elder princes—one then a king, the other in mature youth or manhood—thought the reward inadequate to the task, and were silent. But Alfred, captivated by the prospect of information, and pleased with the beautiful decoration of the first letter of the writing, inquired if she actually intended to give it to such of her children as would the soonest learn to understand and repeat it. His mother repeating the promise with a smile of joy at the question, he took the book, found out an instructor, and learned to read it. When his industry had crowned his wishes with success, he recited it to her. To this important though seemingly trivial incident we owe all the intellectual cultivation and all the literary works of Alfred, and all the benefit which by these he imparted to his countrymen." In this case the beautiful initial letter was the attraction—a letter probably like that which he (the lecturer) had just exhibited as characteristic of the date of Charlemagne. This was the first inducement to study with our English Alfred, and he was not quite sure whether it would not be better generally that children should remain until they were twelve years of age, and then be tempted to read by such inducements as these, rather that we should go on impressing upon their minds in infancy the enormous fallacy that "A" ever was, or under any circumstances could become, an apple-pie.

The main idea of the age of which he was now speaking, however, was that a book was a noble and a sacred thing, to be respected and revered. It became precious because it was written with so much labour and with so much beauty: and then came the idea of its sanctity. It was noble, inasmuch as it was the means of making human thought—the most transient and evanescent of all things—the most permanent of all things. Well, this being the idea of books, which then obtained in men's minds, they worked, and worked on, to attain greater excellence in their writing, by systematizing their colour more and more, until they arrived at a perfect system, which, however, they might have found out long before they did, and which it was strange that we ourselves had not discovered. It was strange that those who were familiar with the Bible, wherein they were told that the colours directed to be used for ornamenting the tabernacle, were gold (or yellow), and blue, and purple, and scarlet, as being those calculated to form the basis of the richest, most harmonious, and glorious combinations, should not have adopted them in all cases where such results were required. The thirteenth-century people, however, had not, it appeared, derived their knowledge from the Bible; they went on working and experimenting until they found it out. Here (exhibiting it) was a Bible of the year 1220: it was but a common example, but worth exhibiting, on account of the clerkly manner in which the letters were written. He now came to the middle of the thirteenth century, when an immense development of the art took place. It was well known that the whole spirit of the middle age was to be found in the writings of Dante: there it must be sought. Dante was the prophet of the middle ages. In his "Purgatory" he introduced a description of certain people suffering the penalty of pride. He represented them as being crushed under great stones, in the position of which we have so many examples in the architectural decorations of that period, as in figures bearing corbels, brackets, &c. It was curious to see what Dante appeared to think most calculated to create the feeling of pride in the human breast. It was not valour, nobility, or success in battles, but excellence in writing. These were his words:—

> "Listening, I bent my visage down, and one
> (Not he who speaks) twisted beneath the weight
> That urged him, saw me, knew me straight, and call'd,
> Holding his eyes with difficulty fix'd
> Intent upon me, stooping as I went,
> Companion of their way. 'O!' I exclaim'd,
> 'Art thou not Oderigi? Art not thou
> Agobbio's glory?—glory of that art
> Which they of Paris call the limner's skill?'
> 'Brother,' said he, 'with tints that gayer smile,
> Bolognian Franco's pencil lines the leaves,
> His all the honour now—my light obscured.'"

The line which is given by Cary (for this is his translation)—

> "Which they of Paris call the limner's skill,"

is not properly translated. The word which in the original is "*alluminare*," does not mean the limner's art, but the art of the illuminator—the writer and illuminator of books. The passage gave a peculiar interest to the illuminated works of the date in which Dante wrote. This period—the middle of the thirteenth century—was marked also by the career of St. Louis, and the next example which he (the lecturer) had to produce, was from a psalter, which was peculiar in having, in addition to the names of the saints, the names of the members of St. Louis's family, with the date of their death, but not of that of St. Louis himself. First, there was the name of Count Robert of Artois, St. Louis's brother, who lost his life while charging the Saracens at Mansourah—just as our light cavalry had charged the Russians at Balaklava. There was thus a note of his death which was put down as a sort of martyrdom. Then there were the names of King Philip II., then that of Louis VIII. the father, and of Blanche of Castile, the mother of St. Louis, but not his own. Now Queen Blanche died in 1252, and St. Louis himself in 1270, so that it was evident this psalter was written between those two periods, and the different portions of it at some distance of time from each other. The leaf exhibited was one of the common leaves taken from the beginning of the book. The flourish of the initial letter he had enlarged, in order to show more clearly what sort of a thing it was. The prevailing colours were blue, purple, and scarlet, with gold: leaves were introduced, and the ornament, it would be perceived, was constantly changing in form and in the curve and lie of the leaf. If there were no change there could be no life. That might be taken as the great rule of art.

He might, while upon this point, remark, that one of the great evils of the day was an intense love of symmetry. Nothing in nature was perfectly symmetrical. No two sides of any animal, tree, or other natural object, were exactly alike. Try to brush your hair exactly alike on both sides, and you will find it could not be done. A statue to be graceful must not have the arms and legs in the same action on both sides; they must be in different actions. In nature they always *were* in different action. In sculpture, in painting, as in everything else, in art as in nature, without dissimilarity there could be no grace. The next specimen he would present to their notice was a capital letter at the beginning of a psalm. In this they would observe, that animals, as well as natural leaves, were introduced. Up to this period nature had not been followed in writing to the same extent, but had been treated in the manner represented in the previous examples. The little Bible he had in his hand, in which the initial capital, of which the letter he exhibited was an enlargement, occurred, was a good example of the style of writing of the year 1230. Here, they would observe, the prevailing colours were the same, blue, purple, and scarlet, with white introduced at intervals, like beautiful pearls. It was a great point in the arts—which many did not seem to be aware of—to know how precious white was. Here were two of the introductory leaves of a psalter which he wished to bring to notice, on account of the human faces introduced in the ornament of the letters. One of these illuminations represented Solomon, having been named David's successor, being made to ride upon the king's own mule, and the burial of King David. Both of these examples were remarkable for the beauty of the faces. Outline and colour were, however, the principle of these examples; beyond that there was no imitation of nature. But from this they began to enrich their MSS. more and more: the systematization of colour went on until they reached a point of enormous luxury. With that luxury of ornament and colour came carelessness, and the gradual degradation and decline of the art. The MS. now produced, one given to Queen Blanche, in the sixteenth century, exhibited that carelessness and degradation in a marked degree. The art having reached its culminating point about the middle or towards the close of the thirteenth century, from that period began to decay, the principles of it having been lost sight of in the attempt to attain greater luxuriousness of drawing and effect, those principles which he insisted upon as the fundamental principles of the art being clearness of outline, and simplicity of colour, without the introduction of light and shade. He had said that writers were not reverenced sufficiently in these days—he said also that neither were painters reverenced as they ought to be. It was a very difficult thing to paint well—much more so than most people imagined, and to lay on light and shade properly, to realise and to convey upon canvas a thorough impression of the varying effects of sunshine and shadow, in the colour of the air, and in the tints given to every object in nature, was a far more difficult thing than most men were capable of accomplishing. This was the reason why we had so few really good painters, and so many bad paintings. There had been never more than three or four really good painters in the world in any one age, and no wonder, for it required talent of a very rare order to be a painter in the higher sense of the term. It was as difficult, and required a natural capacity as extraordinary, to be a good painter, as it did to be a Duke of Wellington; but though it was necessary to possess a first-rate capacity, and talents of the highest order to be a painter, it was not so to enable persons to outline truly from nature, and to lay on simple colour beautifully. This also was a peculiar gift not possessed by every one; but it was a gift which hundreds of persons possessed naturally. Amongst dressmakers there were many who instinctively, as it were, evinced an aptitude at arranging flowers and putting on colour, so as to throw in depth or light as required, for the purpose of producing harmonious combinations, and the instinct to arrange bouquets of flowers so as to combine in harmony the various hues was common. But the mischief was, that when young people were found to possess the talent of outlining or arranging colour in more than an ordinary degree, they were pressed to learn to draw, though they might not have brains enough ever to draw well. He would urge upon those of his audience who had the gift of colour, not to allow it to be checked or run away with by pursuing that which it was more than doubtful that they would ever succeed in. There might be first-rate art exhibited in the pursuit of colour only. The field was narrow, no doubt; but if a man made up his mind to be an illuminator—if he possessed the gift of arranging colour, and his opportunities and time did not admit of his making himself a good painter, then let him take up this principle, that every form he drew must be in pure colour, without shadow. He might use what colours he pleased, but let him not resort to shadow in any shape—the object should always be represented in gradated pure colour, with true outline. The first step was to be perfect master of outline. Outline was susceptible of great beauty and infinite variety; but it must be firm and true; not thickened on the side opposite to the light, with a view of showing something like a shadow. It must not be shadowed at all. Nothing could be more absurd than to attempt to throw in shadow by thickening the line, for if the outline was ever lost, it would oftener be on the dark side than on the light side. Besides, the veracity of the line would lie within the compass of a hair. It must be right or wrong. If right, the thickening of the line destroyed the correctness, and the thickness must be removed before the outline could be true, the truth lying somewhere within the thick line.

The first thing to practise was perfectly faithful outline, and an important thing to know was how much could be expressed by it. Here was an example of the fourteenth century, containing nothing but outline. They would observe that there was a blue bird in the composition, which appeared all but animated, because it was as far as it went so beautifully drawn. This example, and some of the others, would however appear to those who were close to them somewhat coarse, in consequence of their having been considerably enlarged from the original MS. But there might be as much perception of nature in working out these mere outlines as in working out a fully shadowed drawing, like one he now exhibited (a bunch of leaves very far inferior as a work of art to either of the examples of MS. shown), and it was much better that they should possess, for the purposes of decorations generally, the daring conventionality of colour shown in other specimens he submitted to them with pure outline, than that they should be imitators of the spurious examples produced by painters who could not paint, and which violated the eye wherever they were seen. He had said that the peculiar character of the decorative work of the thirteenth century, was the introduction of nature, and that was the circumstance that would make it especially agreeable to those who pursued this art now, if it could (as he hoped) be revived amongst us. In practising it, they need not limit themselves to birds and leaves, as in the examples before them, but might avail themselves of every natural object. As soon as they could trace an outline correctly, he wanted them to watch closely every living object around them—groups of children in the streets, leaves, trees, birds, and the animals in the Zoological Gardens; but he would warn them against introducing too much; and when they were painting, let them never introduce the same letter twice, or the same figure or animal twice in the same composition.

Now, what were the fields for an occupation of this kind?

This was a serious question, and unless the change took place which he was now striving to bring about, he found himself wedged in between two difficulties. He frequently received letters from persons who said to him, "Build us a house, or paint us a room in this way." The reply he was compelled to make was, that he had not the workmen who could do it; and then it was said, naturally enough, that he was a humbug. He went to the workmen, and they said, "We cannot devote our time to that kind of work; there is no demand for it, and we could not earn our money by it." Now, he had asked the students and workmen to come together there that day that they might aid him in the attempt to revive the art to which he had been directing their attention, by recommending to those by whom they were employed to introduce this kind of decoration wherever opportunity offered. There was a great field for it in ornamenting the interiors of churches. There was the lettering of the Commandments, and the writing over the communion-table, the windows, and other ornamental work, where illuminated letters might be introduced with great effect. The patterns might be perpetually varied, and animals, birds, leaves, trees, and other natural objects might be made to give life and diversity to them. But he would urge upon them, whenever they were required to paint anything in a church, to do it as well as they could, and to introduce as much of nature as they could in a graceful manner. Then there was the decoration of rooms—though upon that point he confessed he saw considerable difficulty. He liked pictures and prints in rooms, and would, as far he could, induce people to buy them, and the examples he had exhibited certainly would not look well with those. He would say nothing further upon this point therefore, except that he should like to receive the advice and suggestions of workmen themselves upon it. In the lettering on the outside of shop-fronts, illuminated letters might appropriately be employed, and would form a pleasing change from the dingy appearance which many of the shop-fronts, especially in the metropolis, presented. He would urge upon them, when they had shop-fronts to decorate, to endeavour to induce the shopkeeper to allow them to introduce such letters. He believed the effect would be good, but he was not over-sanguine when he looked at that unhappy thing in Leicester-square, which was abominably ugly, in spite of its colour.

Another, and a most important field for the exercise of this art was the decoration of books. He did not say that every book should be illuminated; some books, as the Bible, should, he thought, be as simple in lettering as possible; but books of poetry or art, which might be very appropriately decorated as suggested. He was anxious to see a taste for decorating books in this manner, because he believed we were falling into a very careless way of regarding our books. It might be that we had so many books now as compared with what persons in similar positions in life formerly possessed. It had been said that it was better to have a few books than many; he could not say that that was his feeling; he considered it a most delightful thing to have a library; at the same he should like people to value and love their books more than they did. The feeling that prevailed in the middle ages with regard to books was, that they were holy things, and those who were employed upon them felt that they were engaged upon a holy work. He would like to bring back something of that feeling, and he would also like to bring back for the workmen the employment of illuminating books, for he thought it must have been a most happy employment. He did not know at what cost now an illuminator might be able to produce a finely-illuminated page. That was a subject on which he was anxious to obtain information. He wanted to have the data, and if the workmen would furnish him with that, he would endeavour to bring the subject before the public. What he wanted was, the information to enable him to say, when asked, what would be the cost of illuminating some beloved book which it might be desired to preserve as a valued work in a family. He thought very many would gladly avail themselves of the opportunity, if it were offered them, to have books of this character so decorated to be preserved as heirlooms. For his own part, he would rather have an illuminated book in his library than a picture. He would like to have a book of which every page was a picture.

The great point was to make this art of book illumination fashionable; if that were done, it would go on as a matter of course. A new school of art would be introduced; the eye for colour would become disciplined; the perception of truth and form in outline would become disciplined; and the art of painting would be more and more appreciated. A Titian could only be appreciated by those who understood harmony of colour. It was not the extraordinary effects of the light and shade—beautiful though they were—that marked the true Titian, so much as the beautiful harmony of his colours; and by disciplining the eye to those harmonies a feeling would be created in the public mind which was now almost dead. There was another advantage that would result from the revival of this art to the student and the illuminator. He could not imagine a happier life than that which would be led by any person of quiet and studious habits with something like the disposition of the old monks who were the illuminators in past times, while following this occupation. If it were cultivated, a totally new impulse would be given to art in every direction, and possibly also to literature, for people would feel that it was better to have a monument in the shape of an illuminated book than in that of an illuminated window; and many a man engaged in writing a book would feel more interest in his work, and take more care in its composition, if he knew that it was to be beautifully illuminated, to be placed in a library as a beloved thing, to be handed down from father to son, and from generation to generation, than if it were printed in the ordinary way, tossed about by printers' devils, and thrown aside as soon as read.

As showing the kind of life he would encourage, he would ask permission to read a passage from Longfellow, describing the Friar Pacifico transcribing and illuminating the Gospel of St. John:—

"It is growing dark! yet one line more
And then my work, for to-day is o'er;
I come again to the name of the Lord,
Ere I that awful name record,
That is spoken so lightly among men,
Let me pause awhile, and wash my pen;
Pure from blemish and blot must it be
When it writes that word of mystery!
Thus have I laboured on and on,
Nearly through the Gospel of St. John.
Can it be that from the lips
Of this same gentle Evangelist,
That Christ himself perhaps has kissed;
Came the dread Apocalypse?
It has a very awful look,
As it stands there at the end of the Book.
Ah me! when I think of that vision divine,
Think of writing it line by line,
I stand in awe of the terrible curse.
Like the trump of doom in the closing verse.
God forgive me! if ever I
Take aught from the Book of Prophecy;
Lest my part, too, should be taken away
From the Book of Life on the Judgment-day."

Then notice the change of feeling—how natural!

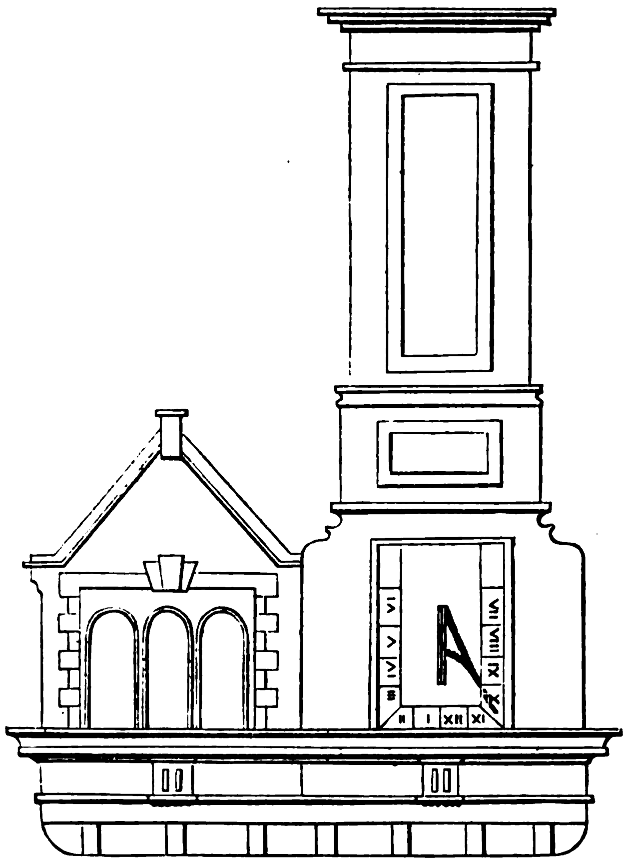
"This is well written, though I say it!
I should not be afraid to display it,
In open day, on the self-same shelf
With the writings of St. Thecla herself,
Or of St. Theodosius, who of old
Wrote the Gospels in letters of gold!
That goodly folio standing yonder,
Without a single blot or blunder,
Would not bear away the palm from mine,
If we should compare them line by line.
There, now, is an initial letter!
King René himself never made better!
Finished down to the leaf and the snail!
Down to the eyes on the peacock's tail!
And now, as I turn the volume over,
And see what lies between cover and cover,
What treasures of art these pages hold,
All ablaze with crimson and gold,
God forgive me! I seem to feel
A certain satisfaction steal
Into my heart, and into my brain,
As if my talent has not lain
Wrapped in a napkin, and all in vain
Yes, I might almost say to the Lord,
Here is a copy of thy word,
Written out with much toil and pain;
Take it, O Lord, and let it be
As something I have done for thee."

He looks from the window:—

"How sweet is the air! How fair the scene!
I wish I had as lovely a green
To paint my landscapes and my leaves!
How the swallows twitter under the eaves!
There, now, there is one in her nest;
I can just catch a glimpse of her head and her breast;
And will sketch her thus, in her quiet nook,
For the margin of my Gospel Book."

This was the kind of life he wished the students of this art to follow. He proposed to leave the various examples he had exhibited in the Museum, that those who desired to do so, might come in if they pleased, and work from them between then and the next lecture. In the next lecture he proposed to explain the general principles of outline, and to exhibit examples; and in the third lecture he intended to explain the principles of colour.

## DORMER WINDOW, HILL HALL.



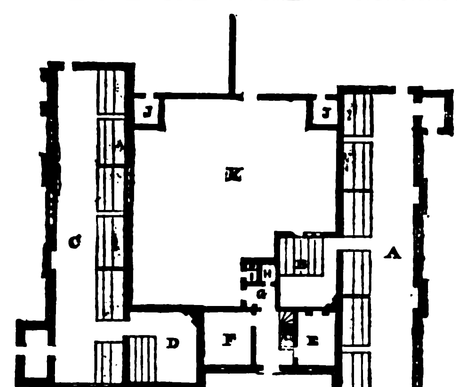
Our engraving represents a Dormer window and chimney shaft with sun-dial, from Hill Hall, drawn to a scale of ¼-inch to the foot, by our correspondent, Mr. Horace A. Alexander, of Stratford, architect. The chimney-shaft is in brickwork.

## THE COAL MINES OF FRANCE.

About a year since, the French government, alarmed for the industrial classes by the rise in the price of coal, resolved to avoid a position which might have materially interfered with their commercial and industrial prosperity. To attain this end, it at first reduced the import duty on English coal, but soon perceived that the remedy applied was insufficient. It became evident that the consumption of coal throughout France was taking such rapid strides that the production did not suffice to satisfy the requirements each day brought forth in immense proportions. In fact, the constant increase of steam navigation and communication by railway, which, as it progresses, reaches districts in which coal was unknown, causes the demand to considerably exceed the supply, and all branches of industry, with their natural developments, necessarily tend still further to increase the consumption. Such a state of things has of course led to a great rise in the price of coal; and in the north as well as in the south of France, coal and coke became so scarce that some establishments had to close for want of fuel; the railways alone having been enabled to procure the coke they required. Some, thanks to their contracts, ensured a supply on moderate terms; but others, less fortunate, have been compelled to pay advanced prices.

The proprietors and shareholders of coal-mines generally have not, so far, profited by these high prices, from the contracts entered into with the State, for marine purposes, with the railway companies and the industrial establishments, which had been completed before the great demand for coal had commenced: but these contracts having now expired, or nearly so, the shareholders and proprietors will consequently begin to profit by the advanced prices. For example—the mines of the Loire, which paid in 1852 but 34 francs, and in 1853 but 42 francs, will in 1854 pay about 50 francs per share. The Grand 'Combe, which paid but 25 francs per share for 1853, can pay 50 francs for 1854, and the results, it is expected, will be similar for most of the colliery enterprises. A ton of coal costs 43 francs at Anzin, 56 francs at the mines of the Loire, 52 francs at Firminy, 56 francs at Blanzy, 63 francs at the Charbonnages Belges, 48 francs at the Grand 'Combe, 60 francs at Commentry, and 30 francs at Portes. Thus, the maximum cost for a ton of coal is that at the Charbonnages Belges, 63 francs per ton, and the minimum at the mines of Portes and Lénéchas, where it is only 30 francs per ton.—*Mining Journal.*

## ST. SIDWELL'S PAROCHIAL SCHOOLS, EXETER.



The Parochial Schools of St. Sidwell's were opened on the 2nd of November. They consist of a boys' and girls' school, each 78 ft. 6 in. by 18 feet, having open roofs of high pitch ceiled against the rafters. There is a girls' class-room 16 feet by 18 feet, and boys' 16 feet by 16 feet. The mistress's residence (built in conformity with the regulations of the Privy Council on Education) connects the two school-rooms. The style of the building is Old English, with square-headed five-light windows with transoms in all the gables, of Bath stone, the walls being of red brick, with tall chimneys of the same material. There are spacious play-grounds. The site was given by the Dean and Chapter of Exeter, and the buildings erected chiefly through the exertions of the incumbent, Rev. J. L. Galton, in raising a subscription, aided by a grant from the Committee of Council.

The contract for the schools was nearly 1500*l.* The cost of boundary fences, 250*l.* The works were carried out by Mr. Ware, of Exeter, from the designs of Mr. Ashworth, of the same city.

*References to Ground Plan.*

A. Girls' School, 78′ 6″ × 18′.
B. Girls' Class Room, 16′ × 18′.
C. Boys' School, 78′ 6″ × 18′.
D. Boys' Class Room, 16′ × 16′.
E. Mistress's Sitting Room, 12′ 6″ × 12′ 6″.
F. Kitchen, 12′ 6″ × 12′ 6″.
G. Scullery, 8′ 3″ × 7′ 0″
H. Pantry.
I. Watercloset.
The other Closets are against the east side of the Play-ground.
There are three Bedrooms over E and F.
J J. Coal Houses.
K. Garden.

## ELECTROTYPE COPPERPLATES.

Among the specimens of miscellaneous philosophical processes of products exhibited at the New York Crystal Palace Exhibition, were some electrotype copperplates, produced at the United States Coast Survey Office. These plates are three in number, and consist of—1, the original engraved plate; 2, a reverse or matrix obtained therefrom by electro deposit; and 3, a "duplicate" or facsimile of the first or original plate, this last being also obtained by electro deposit upon the reverse or matrix No. 2; a printed proof or impression on paper from this latter completes the collection, and affords satisfactory evidence of the perfect manner of conducting the whole operation, all the most minute points and delicate lines being brought out beautifully sharp and distinct. As the several processes adopted in the production of these plates appear to be all of the most improved description, founded on sound philosophical principles, whilst some of them are claimed as the invention of Mr. Mathiot, of the Coast Survey Electrotype Laboratory, under whose able direction the whole work is conducted, a brief description of those processes may not be unacceptable.

The original plate as received from the engraver, is immediately electro-silvered, and then washed with an alcoholic solution of iodine, and exposed to sunshine or bright light. This is found effectually to prevent the adhesion of the electro deposit to the original plate (probably by the interposition of an infinitesimal film of the *vapour* of iodine), without in the slightest degree impairing the sharpness of the impression, the thickness of the coating of iodine vapour being estimated by Mr. Mathiot at *one forty-four millionth* part of an inch; or, upon the supposition that the iodine remains upon the plate in its elementary state, then the thickness of the deposit is estimated at the "*one eighteen thousand millionth* part of an inch."

The plate thus iodised is placed in the vat or decomposition trough in a *vertical* position (the necessary connections with the battery and other arrangements being effected, as usual), and as soon as a sufficient surface layer is produced (which usually takes about twelve hours), the plate with its surface layer is removed to another vat, in which it is placed horizontally with its face upwards, and the positive pole or plate of copper immediately over it, at a distance of about an inch,—the temperature of the copper solution in this horizontal bath being maintained uniformly day and night at about 180°. This is effected by means of a simple furnace with self-regulating damper and an internal coil or helix of pipe, with an upper and a lower tube leading to the corresponding parts of the vat or bath, in which the required temperature is thus maintained by the circulation of the fluid in the ordinary manner; it being found that a peck of charcoal will maintain 100 gallons of the copper solution at any required point between 100° and 200° for twelve hours; the result of such increase of temperature being that a plate of copper ⅛-inch thick, and containing 10 square feet of surface, can be produced in forty-eight hours, or at the rate of 3 lb. to the square foot in twenty-four hours. The quality of the metal produced under such increased temperature being moreover found to be of a very superior description, rivalling in hardness, ductility and elasticity the best rolled or hammered copperplate. This is satisfactorily exemplified in a couple of broad strips of copper, ⅛-inch thick, which are exhibited near these plates. One of the strips is flat, and found to be exceedingly hard and sonorous; the other is twisted up into a sort of open single knot, to prove the perfect ductility and tenacity of the metal.

It may also be mentioned that about 2000 impressions were printed from the first electrotype duplicate taken from the original plate in the Exhibition without its showing any appearance of deterioration, although the lines are many of them exceedingly light and delicate,—so much so, that it is said by competent judges that the original *engraved* plate would probably have failed in producing *one* thousand equally good impressions.

Mr. Mathiot manufactures or produces the negative silver plates of his batteries by electro deposition, and in order to remove from their platinized surfaces the impurities of the zinc plates, which are invariably found to attach themselves thereto, he immerses them *daily* in a solution of per-chloride of iron, which is found to immediately restore the action of the plate, and thus constantly maintain the "*tone*" of the battery.

## REVIEWS.

*Report of the United States Commissioner of Patents for the Year* 1853. Part I. *Arts and Manufactures.* Washington. 1854.

Some alteration has been made in the character of the Reports of the American Patent Office. The usual reports of the Examiners are omitted, on the ground that the Examiners' time might be more usefully employed, and that it was impossible to avoid invidious distinctions between patentees who supposed themselves equally meritorious.

We regret this decision of the Commissioner. The reports of the Examiners we have found most valuable; pointing out to inventors that which had been done before the experiments that had failed, and what remained unattempted, with descriptions of the more interesting of the patents. The only way to avoid all jealousy on the part of patentees, is to appoint as Examiners the most eminent scientific men of the country, and those who are universally considered to be far above all suspicion; and to induce such men to become Examiners, the salary must be increased to such an amount that more profitable employment cannot be sought elsewhere than in the Patent Office. The Commissioner says:—

"The Patent Office should command the highest order of talent. There is no person, whatever be his abilities or his attainments, who would not find, as an Examiner, full exercise for all his talents. A practical sound sense is nowhere more important. All learning connected with the arts and sciences finds here an ample field for exercise; and even questions of law, that tax to their utmost the abilities of the most learned jurists, frequently present themselves for the decision of the office, and should be rightfully decided by the Examiner.

The compensation of the lowest class of Examiners should be such as to command abilities that, with proper training, would grace the highest; and the compensation of all should be sufficient to induce each one in this employment to content himself with making it a business for life, as the information he is daily acquiring is constantly increasing his usefulness."

A material improvement has been made by every patent being fully described, and those which require it being accompanied by a woodcut showing the parts referred to. The Commissioner has gone into the question of the fees required of foreigners; he considers them enormous, and indefensible upon any principle of justice or sound policy, and is greatly in favour of reciprocity. He says:—

"Within the last two years Great Britain has greatly diminished her former high rates of patent fees. It is believed that in no country in Europe are our citizens taxed for these purposes as severely as we now tax theirs. It is well known that some European governments impose a lower rate of fees on an American citizen than he would be required to pay by this office; and yet we continue to charge a British subject $500, and any other alien $300, for that which we grant to our own citizens for $30.

But the granting of a patent is not a mere gratuity by the government: it is the recognition of an evident right in the inventor. No title to property can be more just or valid than his who has created that property. The rule of natural justice is the same in this respect whether the inventor be a citizen or an alien. It is right that the government should charge the patentee with the expense of securing him in his title to what was before rightfully his own; but it is questionable whether a revenue should be sought from this source, except in cases of great necessity. Is there any sufficient reason why the general rule should be departed from in the case of an alien?

It may seem reasonable that we should charge an alien the same fee that his government would charge one of our own citizens under like circumstances; but it should be recollected that European governments make no discrimination between natives and foreigners. The high or low rates are the same for all. Under such circumstances retaliatory measures are not resorted to by us in regard to any other subject.

The oppression to which an alien is subjected at home has never been held as a reason for oppressing him here, even prior to his taking steps to become a citizen. If he holds real estate, we do not levy extraordinary taxes thereon commensurate with what that same property would be taxed if owned in this country by one of our citizens. Why should a different rule be followed in regard to property in an invention?

But there is a reason, founded in sound policy, why greater liberality should be exercised towards a foreign inventor than towards the alien owner of tangible property. He pays a consideration, which the other does not: by taking out a patent, he makes the subject thereof public property at the end of fourteen years. The benefits of the invention are then secure, and can never be lost to the world. High charges deter inventors from parting with their secrets. Many an invention is thus strangled in its birth, which, under other circumstances, might have been developed into something of vast consequence to the world.

There are no lost arts under a liberal and well regulated Patent Office system; and this is one of its great advantages. If foreign nations choose to place these chief means of human progress in subordination to the requirements of their respective exchequers, we are forbidden to imitate them, both by the condition of our treasury and the well-established policy of our government.

Finally, while we extend the free and full benefits of all our institutions to the alien who come hither to seek them, should not a course equally liberal be pursued in regard to inventions,—the creations of his ingenuity? Why should these be subjected to incapacities and discriminating taxation? In regard to them should not the whole world be regarded as one republic, of which we should seek to render our Patent Office the capital, wherein every region should be permitted a free representation? We tolerate no onerous discriminations against the foreign exhibitors in our Crystal Palaces. At the cannon's mouth we extend the protection of our flag to the alien who has simply declared his purpose of becoming a citizen, in the same manner as though he were native born. Ought we to levy a discriminating tax upon the offspring of genius that seek our shores for the express purpose of being naturalised amongst us?

From the preceding considerations it seems evident that a great change should be made as to the fees required from foreign applicants. It is respectfully submitted, whether the most convenient, wise, and beneficial rule will not be to abolish all distinctions growing out of geographical considerations, and to charge every applicant a fair remuneration for the trouble given by him to the office, but no more.

Such a course would be just, generous, and noble; seeking to raise no revenue from those who are the special instruments of human advancement, showing a confidence in the capability of our inventors to cope on equal terms with those of all the world besides, and taking no inconsiderable step in bringing about that great brotherhood of nations for which a higher civilisation is gradually preparing the wolrd."

An augmentation of the fees paid by citizens of the United States is referred to; since the salaries and the number of persons in the office have been increasing, the fees have remained unchanged. A second annual appropriation by Congress is asked, that room may be provided in the Patent Office for the full arrangement and exhibition of all the models; if this be granted, specimens of fabrics and other manufactures and works of art would be classified and arranged in the manner which the law now requires, but which requirement absolute necessity has always compelled the office to disregard.

The whole number of patents issued during the year is 958, including twenty-four reissues, three additional improvements, twelve extensions, and seventy-five designs; the whole number which have expired is 375.

## THE NEWARK ZINC WORKS, JERSEY, U. S.*

Zinc is a metal more sparingly distributed on the surface of the globe than most of the other metals in ordinary use. In Europe our wants are chiefly supplied from the deposits of zinc ores in Belgium and in Russian Poland and Silesia, and the United States market is still largely supplied from the same sources, though recent researches have certified the existence of an enormous deposit in one of her Atlantic States. At the Exhibition of 1851, in the United States Department, a fine specimen of this ore was exhibited in the shape of a mass weighing upwards of 16,000 lb., and accompanied by some of its products. It excited considerable attention on the part of our own, as well as of foreign mineralogists, both on account of the remarkable fineness of the specimen, and of a peculiar mineral "franklinite" with which it was associated. The articles were sent over by the New Jersey Mining and Exploring Company, which, however, were not then very successful in their manufacturing operations. Since that period the company has been reorganised, and under the judicious management of Mr. C. E. Detmold, a gentleman whose scientific acquirements, combined with his well-known skill as an engineer, admirably qualify him for the post, the exploitation has been resumed, extensive works erected at Newark, and an industry firmly and successfully established that bids fair, in the course of a few years, not only to meet the requirements of the home market, but also to furnish a supply to other non-producing countries. Professor Wilson visited the mines at an early part of the summer, and at a later period Mr. Detmold accompanied him through the manufacturing establishment at Newark, which he describes as follows.

The ore, which is the *red oxide*, is worked in Sussex county, in the State of New Jersey; about fifty miles from New York, and is found in a regular vein of 9 feet thick, lying immediately upon a 12 feet thick vein of franklinite in small crystals imbedded in a paste of the red oxide, the proportions of each being nearly equal. The vein has a regular dip of 80°, and rests immediately on the gneiss, the surface being composed of a bed, more or less thick, of a highly crystalline metamorphic limestone. The mining operations are comparatively inexpensive; the ore, lying at a high level, is worked at about $2 per ton; the transport, partly by road and partly by water, to Newark, costs $4 50c. per ton—in all $6 50c., delivered at the works. There the manufacture commences, which at present is confined to one article, the white oxide, so extensively used as a substitute for white lead. Although large quantities of metallic zinc are imported by the States, no attempt has yet been made at the reduction of the ores for that purpose. The ore containing the small crystals of franklinite, when reduced to powder and mixed with oil, forms a deep brown coloured paint, for which a considerable demand has latterly sprung up, as it has been found to be an economical and excellent application to iron surfaces. This, quite recently, has been the means of bringing it into notice.

The manufacture of the white oxide from the red oxide* is very simple, and is effected in the following manner: The ore is first broken down by stampers, and then passing through two sets of iron rollers, is crushed to about the fineness of coarse sand. In this state it is mixed up with about one-third of its weight of fine coal† (screenings), and is then ready for the furnace. The furnaces are constructed after the shape of a long muffle, having a grate at one end, upon which an anthracite fire is sustained, and at the opposite end an aperture with an iron door, which is kept closed, save when the furnace is being charged or the charges being stirred by the workmen. About 800 lb. to 900 lb. constitute a charge, and it requires about eight hours to work off this quantity, so that each furnace works on an average three charges every twenty-four hours, and is kept going night and day, Sundays included. The fire-doors and ash-pit are kept closed, and a large volume of air is supplied by means of an ordinary fan-blast, blown into the ash-pit under the fire-bars. A small portion of the flame passes through the muffle, where the charge (ore and coal) lies, the remainder is carried through the flues, which occupy as much as possible of the exterior of the muffle—the whole being constructed in fire-brick. The furnace is kept at a bright red cherry heat. After having been charged about two hours, the charge begins to give off vapours of oxide of zinc, which increase gradually for four or five hours, during which time the workmen stir the mixture occasionally with long iron rakes. In about eight hours, or sooner if the ore has been crushed very fine, the zinc vapours cease, and the charge is then raked out, and the furnace recharged with the mixed ore, which has meanwhile been heated on the top of the furnace arch. The furnaces are arranged in "banks" of twelve in a row. The muffles communicate by means of vertical cast-iron pipes 18 inches in diameter, with a large horizontal pipe or main 3 feet in diameter. At the point of junction between these vertical pipes and the muffles, an aperture is left, through which a supply of heated air is passed for the purpose of more thoroughly oxidising the zinc vapour as it leaves the muffle.

At the extremity of the horizontal main, a powerful fan-blower is driven with high velocity; this has a double action, drawing the vapour from the furnaces and driving it along the pipe into another portion of the building, called the "catching-house," in which enormous bags made of cotton canvas are suspended horizontally in rows, having a large number of bags of smaller diameter attached to them in a vertical manner with open ends reaching to the floor. The large bags are about 5 feet in diameter and 150 feet in length; the smaller ones are from 18 to 24 inches in diameter. By passing along the pipe, which is made in thick boiler-plate, the oxide and accompanying gases are sufficiently cooled down to prevent their firing the cotton bags, through the meshes of which the gases speedily escape, the oxide remaining behind. The bags are shaken every two hours, when the oxide, which has been collected in them and adhered to their sides, falls down to the bottom, and is then removed into other bags, and carried to the storing-bins.

It is either sold in a dry state in barrels, holding 200 lb. each, or ground up with linseed oil as a paint, and sent to market in

* From the Special Report of Prof. Wilson, on the New York Industrial Exhibition.

* The red oxide is the common oxide of zinc ($Zn.O$), combined with small proportions of manganese and peroxide of iron, from which its red colour is derived. The "franklinite" is composed of the same metals, combined in larger and definite proportions: zinc, 17; iron, 66; manganese, 16 (Berthier).

† The Rhode Island coal was being used at these works.

kegs of various sizes. The oxide of zinc, though perfectly white in a dry state, possesses frequently a greenish tint when mixed with oil and exposed to the action of the light. This probably is due to the oxidation having been imperfect, a small proportion of sub-oxide (?) being sufficient to give it the objectionable tint. Mr. Detmold stated that he expected to remedy the effects by by submitting the oxide to a gentle red heat in ovens which he was erecting for the purpose, and then passing a current of air through, so as more thoroughly to oxidise it. By this process he has been able to produce it of the finest white colour. The present capacity of the works is equal to about 50 tons per week, with a ready market for it for home consumption.

The residuum, consisting chiefly of oxide of iron, manganese, and zinc, resulting from the partially-decomposed franklinite, has been experimented upon very successfully by Mr. Detmold. Iron of the finest quality has been produced from it, very much resembling in its character the "spiegel-eisen" of Germany. The fracture has large and brilliant lamellar facets, sometimes very beautifully crystallised, and so hard as to cut glass readily. Like the German iron, which is produced from the spathic ores of Siegen, Sayn-Altenkirchen, Mussen, &c., it contains fully 5 per cent. of carbon, and nearly the same proportion of manganese, and is easily converted into iron or steel of superior quality.

This method of utilising the residuum is also adapted for the reduction of the franklinite ores, hitherto in themselves of but little value, and will render the secondary products almost of equal value to the staple manufacture. The results of the experiments must be no less gratifying to Mr. Detmold than beneficial to the interest of the company of which he is the president.

## WAREHOUSE OF "LA PROVIDENCE IRONWORKS COMPANY," PARIS.

M. Leonide Marquet, of Paris, *Architect.*

*(With an Engraving and Details, Plate* XXXIX.)*

The "La Providence Ironworks Company" has a large depôt on the Quai Jemappes, on the banks of the Seine, at Paris, in which more than two thousand tons of their productions are stored up. For this establishment a great hall or station has been formed, under the direction of the architect of the Company, M. Leonide Marquet, whose object it was to arrange the above produce according to lengths and sorts in close compass, but so as to leave good wide passages for traffic and for examination of the goods, while he proposed to roof it over on an economical plan, so as to give an example of the cheap application of iron roofing in Paris. For an account of the structure and for drawings we are indebted to Professor C F. L. Förster, of the 'Allgemeine Bauzeitung,' of Vienna, in which valuable publication they have appeared.

As the object of Professor Förster, in giving the details, is to show the actual cost of the structure, we shall follow him in the quantities, measurement, and cost, and it will be necessary to preserve the French measures and currency. The length of the building is 53 metres, and the breadth 30 metres; these are outside measurements. The construction is very simple. Eleven principals, including the two gables, as seen in the Plan view, carry the structure of the roof. Each principal consists of two main beams of double T iron, which are connected together by a system of tie-bars, to prevent the spreading of the principals. These tie-bars are secured to the principals and the crown-plates by two cast-iron pillars, by support bands, and two diagonal bands or rods, by which the connection of all the parts is secured, and stability conferred on the whole structure.

The principals rest upon the inclosure walls, or more correctly speaking, on inner supporting pilasters of ashlar, as will be observed on the Plan view. On these pilasters they are carried by cast-iron shoes (Figs. 1, 5 and 7). The principals are otherwise completely independent of the masonry, so as to allow of the free expansion and contraction of the metal. Indeed, throughout the structure, it is provided as far as possible that the movement of the solids shall be independently exercised, but that they shall be so brought in contact that the elastic properties of the wrought-iron members shall not be disturbed.

The following is the cost of the members of the roof and of the covering:—

* See for the Plate our last number, p. 425.

Principals—(Figures 1, 4, and 7).

| | Kilog. | |
|---|---|---|
| 2 Principals of double T-iron of 0·22m., and together 30·29m. long ... | 794 | 00 |
| 5 Ties and diagonals of wrought-iron rods of 0·040m. diameter, being a total length of 40·20m. (fig. 1) ... | 400 | 00 |
| 2 Cast-iron pillars (fig. 4) ... | 140 | 00 |
| 2 Cast-iron shoes (figs. 5 and 7) ... | 130 | 00 |
| 16 Bolts of 0·040m., with heads and screw-nuts ... | 36 | 00 |
| 8 Flat wrought-iron stirrups of 0·075×0·015, and each 0·78m. long, and strengthened at each end ... | 56 | 00 |
| 2 Connection-plates of 0·45m. long by 0·2m. broad, and 0·014m. deep at the junction of the principals ... } 4 Connection-plates of 0·40×0·24×0·24 at the connection of tie-rods and pillars (fig. 4) ... } | 40 | 00 |
| 4 Plates at the connection of the pillars and principals 1m. long, 0·18m. wide, and 0·011m. thick (fig. 4) ... } For securing the same, 20 bolts of 0·15m. diameter, with heads and hexagonal nuts ... } | 80 | 00 |
| Total kilogrammes ... | 1676 | 00 |

Intermediate Connections.

| | | | | |
|---|---|---|---|---|
| 16 rafters and ridges and 1 crown ridge of double T-iron, the rafters in lengths of 15·60m., and the iron 0·05m., and with the necessary bolts ... | 2512 | 00 | | |
| Total weight of a compartment of the roof ... | 4188 | 00 | | |
| Total weight of two compartments ... | 8376 | 00 | | |
| *Detail of a Compartment with the Skylight.* | | | | |
| The principal as above ... | | | 1676 | 00 |
| 16 Rafters, 11·85m., 16 ridge-plates and roof-ridge, with 15 cast-iron pillars or supports of 10·02 kil. (fig. 3); 5 T-irons, to replace the rafters and carry the skylight-frames (109·50 kil.); 24 glass frames, each 4·16 m. long (378·50 kil.); top ridge-plate ... | | | 2982 | 50 |
| Total kilogrammes ... | | | 4658 | 50 |
| Seven such compartments and connected rafters, &c. weigh | | | 32609 | 50 |

*Weight of a Compartment without Skylight.*

| | | |
|---|---|---|
| 18 Rafters of T-iron, each 15·6m. ... | 1270 | 00 |
| 16 Ridge-plates and one top ridge-plate, each 5·95m., of double T-iron of 0·16m. ... | 1558 | 00 |
| Total kilogrammes ... | 2828 | 00 |
| 109m. of rods of 0·014m. diameter, with screw-nuts for connections ... | 129 | 00 |

Iron-Plate Roofing.

| | | |
|---|---|---|
| 3 Compartments without skylights, at 2151·60 kil. ... | 6454 | 80 |
| 7 Compartments with skylights, at 1638·70 kil. ... | 11470 | 90 |
| Sundries ... | 12 | 30 |
| Total kilogrammes ... | 18067 | 00 |

Glazing.

| | | |
|---|---|---|
| 7 Glazed compartments, of 50 square metres superfice, or 350 square metres of glass double weight ... | 2310 | 10 |
| Total weight of the roof, including the cast-iron shoes, but without the smaller gutters ... | 64290 | 50 |
| This for 1585·50m. of roof surface and 1501·50m. horizontal covered surface, gives a sectional weight per metre of roof surface of ... | 40 | 50 |
| Ditto per metre of roof surface in kilogrammes ... | 42 | 80 |

*Detail of a Compartment with Roofing.*

| | Surface. Metres. | Weight. Kil. | Price per kil. Fr. | Total. Fr. | Cost per Met. Fr. |
|---|---|---|---|---|---|
| Principals, rafters, &c. | 158·55 | 4188·00 | 0·60 | 2512·80 | 15·85 |
| Roofing | 158·55 | 2151·68 | 0·40 | 860.67 | 5·43 |
| Labour | — | — | — | 269·53 | — |
| Total | | | | 3643·00 | 22·98 |

*Detail of Compartment with Skylight.*

| | Surface. Metres. | Weight. Kil. | Price per kil. Fr. | Total. Fr. | Cost per Met. Fr. |
|---|---|---|---|---|---|
| Principals, rafters, &c., 5·25×30·20 | 158·55 | 4658·50 | 0·60 | 2795·10 | 17·68 |
| Roofing, 5·25×23·0 | 120·75 | 1638·70 | 0·40 | 665·48 | } 7·54 |
| Labour | — | — | — | 205·27 | } |
| Glazing 216 sheets 54×43=50 square metres, at 6·50fr. | — | — | — | 325·00 | } |
| Total | | | | 3990·85 | 25·17 |

The total cost of the roof, including gutters and rain-pipes, was 40442·72 francs, or 1618*l.*; that is, per square metre of roof surface, 25·50 francs, and of horizontal surface, 26·93 francs.

Every part of the roof was tested before being put up, and it was carried out under the direction of M. Kaulek, so far as the constructive supervision was concerned.

## IMPROVED TWO-WHEEL CARRIAGES.

F. R. A. GLOVER, *Patentee*, April 7, 1854.

(*With Engravings, Plate* XLII.)

THIS invention for improvements in two-wheeled carriages consists—First, in constructing carriages with compound shafts in such manner that they shall also form or act as springs for supporting the load to be carried, by forming them of two parts attached together near to one end, and open or apart from each other at the other end, and by so interposing between them, near to the open end, one or more separating blocks or stops, that on one of the two pieces being secured at its end to the axle, and the load being placed upon, or suspended from, or attached to the end of the other part (or partly to the end and partly elsewhere), the load, in causing the extremities of the two parts at their open end to approach or come together, will cause the parts of the shaft intermediate between the separating blocks or stops and their point of contact to spring or open away from each other, and on the pressure being removed, to collapse and resume their original form.

Secondly. In shaping the two parts of the compound shafts, as above set forth, as to dispense with any separating blocks or stops, and yet produce the action above described.

Thirdly. In the use of either of the foregoing improvements in combination with the floor of the body of the carriage suspended beneath the axle.

Fourthly. In so constructing the body and arranging the seats that the hind-quarters of the animal may be brought close up to, or very nearly close up to the axle, by fixing the improved shafts above set forth to the axle, so as to enable the carriage to be turned in the narrowest limit, and the line of draught to be shortened to the length of the horse.

The manner in which the improvements may be respectively performed is as follows:—In fig. 1 (Plate XLII.) the side and plan view shows the improved double or compound spring-shafts, constructed of two separate pieces A and B, of any suitable description of wood, such as lance, ash, or red pine, and connected together by an iron protecting band or strap *a*. The upper piece A, is the entire length of the shaft, and the lower piece B, about 15 or 18 inches shorter. The general form and proportions of such shafts, and the manner of using them as springs, are the same as in the shafts made from a single piece of either lance, ash, red pine, or any other suitable wood, which is made of any convenient dimensions; as, for example, 7 ft. 6 in. in length, of a varying thickness from 5 inches at one end to 2½ inches at the other end, and of an uniform width of 2½ inches or 3 inches, or slightly tapering from about 4 inches at the thicker end to about 2 inches at the thinner end. The patentee cuts the wood in the direction of its length and along the middle, so as to divide it into two thicknesses, beginning the cut at the thick part, and continuing it till within about 15 or 18 inches of the thinner end, at which point the wood is protected from splitting or opening further by a band or strap of iron or leather, or otherwise.

Fig. 2 shows a side view of such a piece of wood with a cut run up the centre of it to within 18 inches of the small end; and fig. 3 is a similar view, representing the ends stretched open a little. In the latter figure *a*, is the protecting band or strap. The manner of applying a pair of these shafts and making them the springs of a carriage, is as follows. Supposing the axletree to be divided into three parts, the middle division of which is about 2 ft. 1 or 2 in. in length. The lower portion of each of the shafts is connected at its end *b*, to the axle, one at each extremity of such middle division; and the upper portion of each is fastened at its end *c*, by a hinge-joint to a transverse bar or transom above them. Fig. 4 shows the mode of separating the shafts by the fulcrum-block *d*, which is inserted into one of a series of pairs of morticed holes made for its reception in both portions of the shaft, and marked 1, 1, 2, 2, 3, 3, and 4, 4, so as to admit of adjustment according to the weight to be carried by altering the block from one pair of holes to another. Thus, if the weight were excessive, the blocks should be placed between in the holes 1, 1, and if very slight in the holes 4, 4. It is to be noted, that from the double end of the shafts for about 16 to 20 inches, more or less, each portion should be extremely rigid, and when this cannot be obtained by the wood only, the patentee fastens iron plates or shoes on the sides of these parts of the shafts.

The action of the improved double-spring shaft is represented by fig. 4, the full lines denoting the ordinary relative positions of the upper and lower portions respectively, and the dotted lines the relative positions they assume when any extra stress or weight is brought to bear upon them. The weight of the carriage resting upon or hanging from the end or point *c*, meets its resistance at the end or point *b*, which is connected to the axletree, the blocks being interposed. When extra stress is brought to bear against the point *b*, the tendency of the point *c*, is to approach it, and if the wood of either shaft broke at the fulcrum, the carriage would fall; but if the wood from *c* to *c**, and from *b* to *b**, is sufficiently strong to render that contingency impossible, and the wood from *b** to *a*, and from *c** to *a*, is sufficiently slender to allow the natural elasticity of the wood to play, then when the extra stress is applied at *e*, while the wood from *c* to *c**, and from *b* to *b**, retains its rigidity or inflexibility, the wood from *c** to *a*, and from *b** to *a*, is bowed out, and the result is a downward and upward motion at *e*, similar to that which takes place in an ordinary elliptic spring when extra stress is applied.

The figs. 5 to 7 represent a family car, and which serves as a good illustration of the mode of construction which is intended by them. Fig. 5, a side view of the car; fig. 6, a longitudinal section; fig. 7, a transverse section; fig. 8, a side view of the shafts and transom frame on a larger scale. The carriage consists of a body or case, and an under-carriage. The body consists of a bottom and two sides, which sides are joined together, and kept upright by a cross piece or transom *x*; this transom supports or carries the weight of the carriage or body, and its loading when the body is laid or hung upon the under-carriage. The bottom of the body or case is a rectangular oblong frame, having a similar oblong, but of about half the dimensions taken out of the middle of it from one end. The object of this opened space is to allow the horse's feet to go back so far as to pass under the axletree; by which means the horse is brought as close as is possible to the weight he has to move, and he is enabled to drag almost immediately from the very centre of gravity. The under-carriage consists of the axletree and wheels, and a pair of the improved double-spring shafts, together with a transom *x*, and transom frame *x**, the shafts being secured both to the axletree and to the transom in the manner described, and particularly illustrated by fig. 8. The transom is also secured to the body, and connects the two parts of the carriage together, the connection at the point *c*, being moveable, or more correctly speaking, a hinged joint, as it is important that it should not be a rigid connection.

In order to keep the upper carriage or body from swagging about against the wheels from side to side, he employs two cross-braces or stays of leather or chain, which are stretched or placed between the right end of the axle on one side, up to the left end of the transom on the opposite side, and *vice versâ*, from the left end of the axle up to the right end of the transom, and connects them with the axle and the transom respectively by suitable shackles or fastenings. He also employs two other straps *l*, *l*, fig. 8, which are essential to the easy action of the carriage when the horse trots. These pass completely round the double shafts, one underneath the lower portion of each shaft, and over a projecting arm or portion of the transom frame, which is prolonged for the purpose. These arms are not intended to be strapped down tightly, as this would hinder the proper elastic action of the spring shafts, but their use is simply to hold the floor of the carriage in parallelism to the ground, and to counteract the jogging motion of the horse in the trot. The entire carriage therefore consists of a body, an under carriage, two sets of straps, two for braces or stays, two for counterpoises, and two blocks. The seating of the carriage and the disposition of the weight to be carried has to be attended to as in every other two-wheeled vehicle in which it is necessary to balance the shifting load. The weight should never be thrown on the horse's back. The car is arranged to carry seven persons, including the driver, who sits at a standing seat *m*, fig. 6, on one side of the horse and in front of the car; another person sits in the corresponding place on the opposite side. Three persons sit with their backs to the horse, right over the transom on the seat marked *o*, and two others in the back corner seats of the carriage, which, for convenience, are made so as to let down and hang as flaps when not required to be used, and so as to afford more space to the occupants of the transverse seats. The carriage may be either closed up behind like a box, with a door in the middle, or the back may be altogether open.

It is to be noted, that instead of the lower portion of the shaft being rigidly connected with the axle, as shown in fig. 8, one or both shafts may be loosely connected therewith in any convenient manner, the draught being in either case direct from the axle which has hooks upon it for attaching the traces.

FIG. 1.

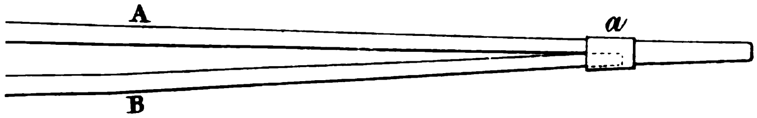



FIG. 2.

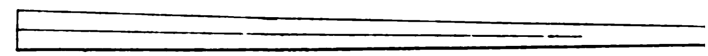


FIG. 3.

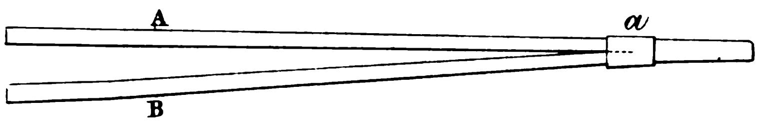



FIG. 4.

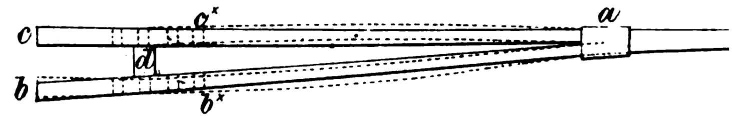



FIG. 5.

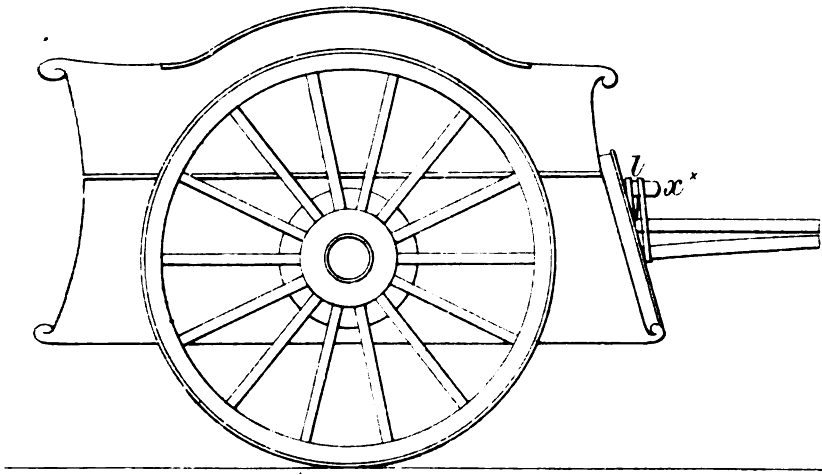



FIG. 6.

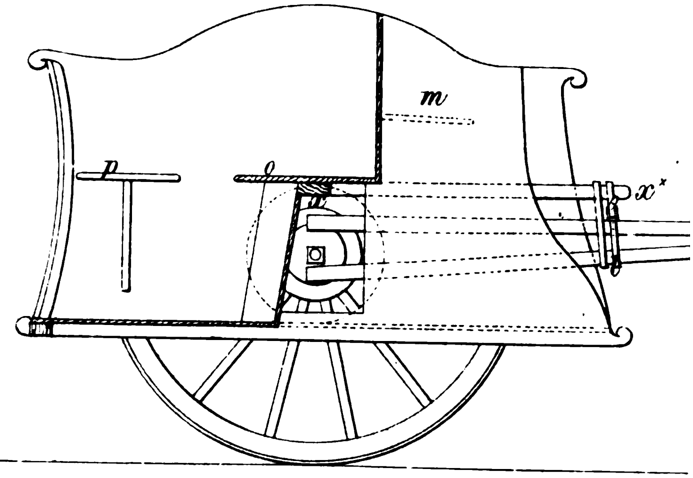



FIG. 7.

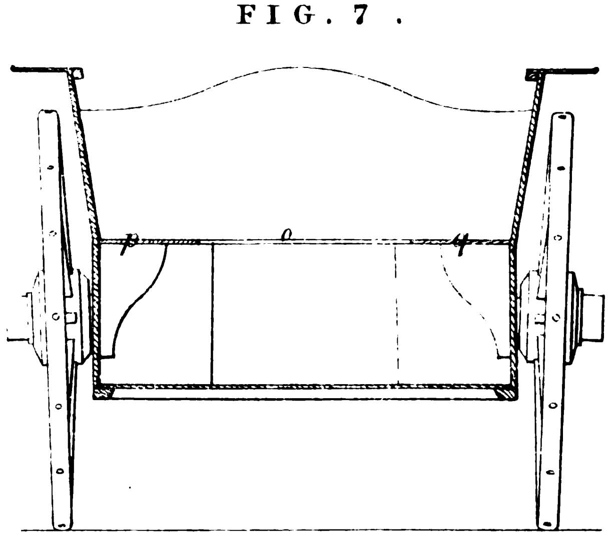
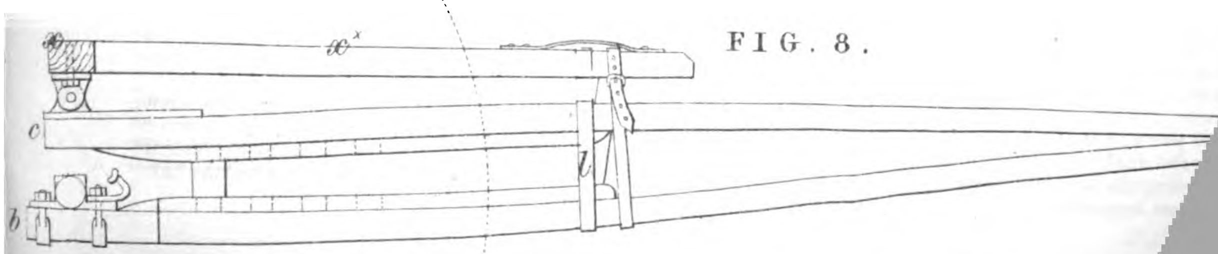



FIG. 8.



## INSTITUTION OF CIVIL ENGINEERS.

*Nov.* 14.—JAMES SIMPSON, Esq., President, in the Chair.

The business of the evening was commenced by the announcement of the dates of the ordinary meetings of the session; of the appointment of December 19th for the Annual General Meeting, for the election of the President, Council, and Officers; and of the 29th May 1855 for the President's Conversazione.

The paper read was *"On the Means of avoiding Smoke from Boiler Furnaces."* By W. WOODCOCK.

The author commenced by explaining the nature of smoke as existing in furnaces, the cause of its formation, its component gases, and the temperature at which they became inflammable, and then pointed out a method of preventing the evolution of opaque smoke by simple and apparently effective means. It was stated that ordinary pit coal, under the process of destructive distillation, gave off various volatile substances, some of which were gases, such as hydrogen, marsh gas, olefiant gas, carbonic oxide, &c.; these and others existed in the furnace only in a gaseous state, becoming liquid or solid when in the external air, and of such coal-tar was composed; and amidst them the carbon, in minute subdivision, was held in suspension, giving to the smoke its sable hue. All these gases were combustible at given temperatures, provided a certain amount of oxygen was present. It was then shown that the air containing this oxygen, if imparted to the gases after leaving the fuel on the bars, must be administered so as not to reduce the temperature of the gases below their "flame-points." The arguments on the chemical composition of smoke were enforced by extracts from a letter by Mr. Mansfield, published in the *Mechanic's Magazine*, in which the subject was fully investigated.

The formation of smoke or visible carbon held in suspension was stated to depend entirely upon the insufficiency of the supply of oxygen in the furnace, as the heat of the furnace would cause the various gases to be given off more rapidly than their combustion could be supported by the quantity of oxygen passing through the fire-bars in the same period of time; this evil being much aggravated by the heat of the air as usually supplied from the ordinary ash-pit, generally ranging from 200° to 300° Fah., and the air at that heat containing less oxygen by about one-third than that at the usual atmospheric temperature, and consequently that the combustion of the fuel to which it was supplied must be one-third less perfect.

The simplest means of preventing the formation of smoke were shown to be by providing for an ample supply of oxygen in a condensed state, in the form of cold air, to the fuel on the fire-bars, and by administering such further supply of oxygen to the heated gases as might be necessary for their complete combustion whilst in contact with the boiler; this latter supply being given at such a temperature as would insure the successive ignition of the gases as they were evolved. Thus, by establishing nearly perfect primary combustion, the quantity of smoke evolved was shown to be reduced to a minimum, of which no visible trace ever reached the summit of the chimney.

The apparatus by which this desirable end was attained was described to consist of two parts, each being the addition of a very simple apparatus to the ordinary boiler-furnace. The first of these was a double set of thin iron bars, lying horizontally in the direction of their length, parallel to each other, immediately beneath the grate in the ash-pit. Each set of bars resembled a Venetian blind in its arrangement; the bars being inclined at an angle of 45° to the horizon in the direction of their width. The bars of the two sets were thus inclined in opposite directions, and being so close together that a vertical straight line could not pass between any adjacent pair of them, yet far enough apart to allow all cinders to fall freely through, and the air to pass freely upwards to the fire. The bars were of the same length as the grate, so as to extend from front to back. It would be perceived that the effect of this arrangement must be to screen the ash-pit completely from the heat radiated directly downwards from the grate, and so that scarcely any would pass through by reflection. In fact, not a ray of heat could reach the ash-pit from the furnace without suffering four reflections from rough iron surfaces, which would leave a mere shadow of a ray for further progress.

Thus a large quantity of heat, which otherwise would be radiated out of the furnace into the ash-pit, thence reflected, and so lost, was saved for the boiler. The ash-pit also was only slightly heated by the cinders which fell through; and this source of heat might be reduced to any extent by frequently removing the rubbish from the pit. Another consequence was, that the air passing from below through the grate, not being heated in the ash-pit, entered the fire cold, and therefore not, as it did from ordinary ash-pits, in a rarefied condition. By its coolness, this air prevented to some extent the burning of the grate-bars; and by its unrarefied state it produced a more intense and rapid combustion of the fuel after it had passed the bars.

Another part of the contrivance was more especially the smoke-burning apparatus. It consisted of a set of tubes, open at both ends, passing through the furnace horizontally from front to back, and terminating within the wall of the front of the bridge, with valves to regulate the access of air into the tubes. The fire-bridge differed importantly from that of an ordinary furnace. It was hollow, and was divided into two parts, the larger of which stood up from below; the other, which was shallower, was in contact with the boiler. Between them all the products of combustion passed from the furnace. The two parts communicated with each other by channels at the sides, and thus formed together an annular chamber. The tubes before mentioned entered the front wall of this chamber, and thus established a communication between its interior and the outer air. The back wall or plate, both of the upper and of the lower part of this chamber or bridge, being perforated with numerous holes, opening from the interior of the bridge to the space beyond it, established a direct communication between the outer air and the throat of the flue. There was a second solid bridge beyond the first, descending from the upper side of the flue; this, by interrupting the direct channel through that part of the passage, retarded the flow of the smoke and gases, and caused their perfect mixture with each other within the space between the bridges.

The result of this arrangement was, that a current of highly-heated air, which passed through the tubes in the furnace, escaped at the bridge, through the perforations in the back wall, and mixing with the gases from the furnace which held the smoke in suspension, converted the smoke into flame.

It was contended, that by the adaptation of this apparatus to marine-boilers, the high temperature of the stoke-holes and boiler-rooms would be obviated, and that the steam-vessels would not be so evident from a distance as they now were, by the volumes of smoke they gave out; and by having a telescopic sliding funnel, and substituting, during the period of being in action, a horizontal tube with a small fan-blower, any injury to the main funnel would be effectually prevented.

It appeared that the results of this apparatus had been very satisfactory; that at Messrs. Meux's brewery there was not the slightest appearance of opaque smoke from the chimney, and that the money-saving, resulting not only from the more perfect combustion of the fuel, but from the use of an inferior quality of coal at a lower price, amounted to full 20 per cent. This success was so great as to warrant the introduction of the apparatus to the more general notice of the profession and the public, through the Institution of Civil Engineers.

*Nov.* 21.—The discussion being renewed on Mr. Woodcock's paper, it was shown, that although critically precise experiments for determining the amount of evaporation had not been previously made, there was no doubt of the fact of its being possible to use a lower-priced fuel, and to do the full amount of work with the boiler, without evolving any opaque smoke from the chimney; and thus, whilst complying with the requirements of the Legislature, a pecuniary saving could be effected. Recently, however, by experiments on a cylindrical boiler 17 feet long by 3 feet diameter, it had been shown, that $8\frac{6}{10}$ lb. of water injected at 42° Fah. was evaporated by 1lb. of Newcastle small coal, when Mr. Woodcock's apparatus was in use. It was found, that with small bituminous coal, a better evaporation was maintained than when Llangennoch coal was used, and without any appearance of smoke. The cast-iron bridges of the furnace did not appear to suffer from the effects of the fire; the passage of the air keeping the metal comparatively cool.

As soon as the valves of the apparatus at Messrs. Meux and Co's Brewery, were closed, there was a dense smoke; but on the instant of opening them, the heated gases combined with the oxygen of the air and flashed into bright flame. Llangennoch coals had been generally used at Messrs. Meux and Co's brewery, not from any economy they offered, as they were not so strong as the Newcastle coals, but for the sake of the neighbourhood, as they did not give out opaque smoke; however, with the apparatus described by Mr. Woodcock, small Newcastle slack could be used, and as it could be purchased at fourteen shillings per ton, whilst Llangennoch coal cost twenty-eight shillings, there must be a money-saving and the boilers worked quite as efficiently.

As to the general similitude between the principles advocated by Mr. C. Wye Williams, and those brought into notice by Mr. Woodcock, almost the only difference appeared to be, that the former insisted on the necessity for the coldness of the air admitted, whilst the latter contended for the advantage of heating the air, prior to its mingling with the gases. On this point many conflicting opinions were given, and examples quoted. It was, however, allowed, that the arrangement of the Venetian blind screens, below the grate bars, was novel, and was likely to be beneficial in preventing radiation into the ash-pits; and thence into the boiler rooms of steam vessels, and there would not be any inconvenience from not being able to introduce prickers from beneath the bars, as good stokers always cleared the bars from above, by the use of the T head tool, and none but idle, or bad stokers allowed the clinkers to accumulate, so as to run between the bars, and require the use of the pricker.

The use of heated air was practically contended for, because, when the air was admitted at a low temperature, there was a certain amount of loss from the chilling effect of the stream or film of air, before it mingled with the gases; whereas this effect was not perceived when the air was admitted at a certain temperature. Under Mr. Williams's system, this had been attempted to be provided against by multiplying the number and diminishing the individual area of the apertures for admitting air; but it was argued, that by extending the number of apertures still more, and previously raising the temperature of the entering air behind the bridge, the object would be more certainly attained. The system of supplying air at a very elevated temperature under gas retorts, had been very advantageously employed for many years, in conjunction with the hollow bridge, originally introduced by Mr. Farey, the father of the late Mr. John Farey (M. Inst. C.E.) In corroboration of these views, it was stated, that on board one of the "Citizen" steam-boats on the Thames, by a free admission of the air only through a series of parallel wire gauze screens in the fire-door, so as to distribute it in minute jets, the exhibition of opaque smoke had been prevented, whilst a saving of fuel was effected, without any loss of speed, or any extra labour to the stoker. A hollow bridge was also used, and a blast-pipe being extended from the base of the funnel, and opening into the bridge, further beneficial effect had been produced.

A model was exhibited of a hollow cast-iron bridge plate, with a series of vertical ribs, so arranged as to form tubes, leading up from the ashpit to the apex of the bridge, where the air mingled with the heated gases, and passed away in flame. The currents of air up these bridge tubes preserved the iron from destruction, by carrying off the caloric, and it became heated in its upward course.

The introduction of cold air was advocated, on the ground that a mass of air, once broken up into films or minute jets, would not again unite, but that each particle would pursue its independent course, until it combined with the heated gases. Therefore, the system of admission by the perforated fire door, so as to pass over the incandescent fuel, had been so strongly advocated.

It was urged that mechanical or other means should be adopted for regulating the proportion of oxygen, according to the state of incandescence of the fuel on the bars. This, it was contended, was virtually accomplished through the side tubes of Mr. Woodcock's apparatus; as it had been shown, that the velocity of the passage of air through the tubes, was exactly in proportion with the demand for oxygen by the fuel. That the air was really heated in its passage had been shown by inserting a thermometer, protected from radiated heat, into a flue in connection with the hollow bridge.

The question of the applicability of most of the systems of preventing the exhibition of opaque smoke, was shown to depend, to a great extent, on the area of the fire-grate and the size of the boiler, for, if both were restricted, so as to demand an excessively rapid draught, there could not be a sufficient mingling of the gases to insure perfect combustion.

## ROYAL SCOTTISH SOCIETY OF ARTS.

At the annual general meeting of this Society, on the 13th ult., the following Report of the Prize Committee awarding the prizes for Session 1853-54 was read, and the Prizes were delivered by the President to the successful candidates:—

1. To Thomas Stevenson, F.R.S.E., C.E., Edinburgh,—for his "Description and Drawings of Dipping and Apparent Lights for Sunk Reefs and Pier-heads of Harbours."—The Society's Gold Medal, valued Ten Sovereigns.

2. To James Elliot, Teacher of Mathematics, Edinburgh,—for his "Mechanical Illustrations of the Planetary Motions," including an Illustration of his Theory of the Stability of Equilibrium of Saturn's Ring.—The Society's Silver Medal, value Ten Sovereigns.

3. To Robert Henry Bow, C.E., Edinburgh,—for his "Description of New Designs for Iron Roofs of great clear span," &c.; with Drawings.—The Society's Silver Medal, value Ten Sovereigns.

4. To William Swan, F.R.S.E., Teacher of Mathematics, Edinburgh,—for Description of his "Simple Variation Compass."—The Society's Silver Medal, value Five Sovereigns.

5. To John Scott, Teacher of Mathematics, Edinburgh,—for his paper "On New properties and applications of Spiral Pumps, &c., with Models and Diagrams."—The Society's Silver Medal, value Five Sovereigns.

6. To George Mitchell, 101, High-street, Edinburgh,—for his Description of a "Safe Lock, incapable of being opened by any other means than by its own key."—The Society's Silver Medal, value Five Sovereigns.

7. To the Rev. James Brodie, Monimail, Fife,—for his "Enquiry into the principles on which the action of Sails and Rudders depends, with Diagrams."—The Society's Silver Medal.

8. To J. T. Thompson, F.R.G.S., C.E. and Government Surveyor at Singapore,—for his Description and Drawing of a "Semi-Revolving Light for Lighthouses."—The Society's Silver Medal.

9. To Thomas Rodger, jun., St. Andrews,—for his paper "On Collodion Calotype," with Illustrative Specimens.—The Society's Silver Medal.

10. To Alexander Melville Bell, Teacher of Elocution, Edinburgh,—for his Paper on a "New Principle of Stenography or Shorthand Writing."—The Society's Silver Medal.

11. To Thomas Steven, Builder, Bonnyrig, Lasswade,—for his Description of a "New Method of Shutting Doors," with a Model.—The Society's Silver Medal. The Committee have also recommended the Model to be purchased for the Museum.

## NEW PATENTS.

### PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAW AMENDMENT ACT.

*Dated August 30.*

1899. L. P. Lehugeur, and M. Uttinger, St. Denis, near Paris—Improvements applicable to machinery for printing fabrics

*Dated September 4.*

1927. J. Parker, Birmingham—Improvement or improvements in the smoke-boxes of locomotive engines

1936. J. F. H. H. H. de Lavaur, Paris—Improvements in securing waterproof wrappers or coverings used in packing goods

*Dated September 8.*

1959. S. Frearson, Glascote, Warwick—Improvements in the construction and manufacture of buttons, a part or parts of which improvements may also be applied to other similar purposes. (A communication)

1960. T. Petitjean, Upper John-street, Fitzroy-square—An improved process for recutting or reforming the faces of files

*Dated September 12.*

1984. R. Laming, Carlton Villas, Maida Vale—Improvements in purifying gas from ammonia and other impurities, and preparing pure gas for burning, in obtaining ammonia and certain salts of ammonia and soda and in treating certain salts of ammonia

*Dated September 20.*

2024. A. Tylor, Warwick-lane, Newgate-street, and H. G. Frasi, Herbert-street, New North-road—Improvements in water-closets

*Dated September 26.*

2072. T. Griffiths, Madeley, Shropshire—An improved pump for raising and forcing water

*Dated September 30.*

2097. W. Wilkinson, Nottingham—Improvements in looped pile and cut pile fabrics, and in machinery for brushing or raising a cut pile or fleece upon the web on both sides the article, or on one side only, by which means he secures a looped web not liable to let down

2099. W. Tucker, Old Brompton—Preventing the escape of the fuliginous smoke from shafts and flues

2101. T. Collins, Gayton, Northampton—Improvements in manufacturing bricks and tiles

2103. M. Poole, Avenue-road, Middlesex—Improvements in condensers. (A communication)

*Dated October 2.*

2105. A. E. L. Bellford, Castle-street, Holborn—Improvements in suspended purchases (A communication)

2107. G. Wall, Manchester—Improvements in the manufacture of railway tickets and other similar articles from a substance or material capable of being re-used

2109. T. Sherriff, Glasgow—Improvements in moulding or shaping metals

2111. F. Durand, Paris—Improvements in looms for weaving

2113. N. Bennett, Furnival's-inn, Holborn—A substitute for the scaffolding at present employed in and for the erecting and repairing of buildings (A communication)

2115. C. Hill, Chippenham, Wilts—Improvements in the manufacture of pulp

*Dated October 3.*

2117. J. Hammond, Brunswick-street, Blackfriars-road—Holding a book in such a position that it may be read with ease and comfort in an erect, reclining, or completely recumbent position, to be called "Hammond's suspension reading-desk"

2118. W. Tatham, Rochdale—Improvements in machinery or apparatus for preparing, spinning, doubling, twisting, and winding cotton, wool, flax, silk, and other fibrous substances

2119. W. Blyth, Oswaldthwistle, and E. Kopp, Accrington, Lancaster—Improvements in the manufacture of soda-ash and sulphuric acid

2121. A. V. Newton, Chancery-lane—Improvements in motive-power engines applicable to the working of their valves and to the conversion of the reciprocating motion of such engines into rotary motion. (A communication)

2123. W. McNaught, Rochdale—Improvements in slide-valves for steam-engines

2126. W. Townend, Harden Bingley, York—An improvement in combing wool and other fibres.

*Dated October 4.*

2127. J. Kershaw, Stockport—Improvements in self-acting mules

2128. F. S. Thomas, Cornhill—Improvements in locomotives

2129. F. S. Thomas, Cornhill—An improved mode of obtaining motive power

2130. D. Chalmers, Manchester—Improvements in the mode or method of working railway breaks, and communicating signals

2131. W. P. Gaulton, Crag Works, near Macclesfield—Improvements in breaks applicable to railway carriages and other vehicles

2132. J. Disher, Edinburgh—Improvements in mashing-apparatus for brewing

2133. A. A. J. Legentil, Arras, France—Improvements in pumps or machinery for raising and forcing water and other fluids

2134. T. Crossley, Scott's-yard, Bush-lane—An improved mode of manufacturing printing-blocks. (A communication)

2135. T. Prosser, New York, U.S., now of Birkenhead—Improvements in the manufacture of certain hollow closed vessels, and in the machinery or apparatus employed therein, parts of which improvements are also applicable when preparing for and fastening tubes into steam boilers, or other vessels requiring tubes to be fixed therein

2136. W. H. Phillips, Camberwell New-road—Improvements in rotatory steam-engines

2137. T. W. Rammell, Trafalgar-square—Improvements in steam boiler and other furnaces

2138. J. Perry, Hunslet Old Mills, near Leeds—Improvements in preparing wool for combing

*Dated October 5.*

2139. T. E. Moore, Great Titchfield-street, Marylebone—Improvements in machinery or apparatus for curvilinear and annular cuttings in metals and other hard substances

2140. W. B. Adams, Adam-street, Adelphi—Improvements in rails for railways, and in the connections and fastenings for rails

2141. E. O. Tindall, Scarborough—Improvements in mangles and wringing-machines for smoothing and wringing clothes and woven fabrics

2142. T. Harris, Nantiglo, Aberystruth—Separating the steam from the condensed water and mud in its transit from the boiler to the cylinder of a steam-engine, stationary or locomotive

2143. G. Collier, Halifax—Improvements in the manufacture of carpets and other terry fabrics

2144. W. Frost, Wine-office-court, Fleet-street—Improvements in steam-engines

2145. T. Bennett, Woodbridge-street, Clerkenwell—Improvements in the apparatus employed in the manufacture of gold, silver, and metal leaf.

2146. J. A. Lander, Southwark-bridge-road—Improvements in machines employed in and for the manufacture of spikes and nails

2147. J. M. Dunlop, Manchester—Improvements in machinery or apparatus for preparing, spinning, and doubling cotton and other fibrous materials
2148. F. Durand, Paris—Improvements in circular looms

*Dated October 6.*

2150. J. Britten, Birmingham—A new or improved machine for sweeping or cleaning chimneys
2151. P. Kerr, Paisley—Improvements in the treatment and finishing of threads or yarns

*Dated October 7.*

2152. W. Chambers, Hampson Mill, near Bury—Improvements in machinery for beetling cotton and other fabrics
2154. R. W. Uren, Foggington, Devon—Improvements in machinery for the manufacture of bricks and tiles
2155. G. T. Selby, Smethwick—An improvement in furnaces
2156. J. B. S. Méritens, Paris—Improvements in the mode of dyeing cotton, flax, and other fibrous substances, and fabrics generally
2157. T. Roberts and J. Dale, Manchester—Improvements in obtaining and treating extracts from certain dye-woods, and in apparatus for obtaining such extracts
2158. W. Johnson, Lincoln's-inn-fields—Improvements in windlasses. (A communication)
2159. R. Maynard, Whittlesford, Cambridge—Improvements in machinery for threshing and dressing grain

*Dated October 9.*

2160. J. Aikman, Paisley—A roller for scouring and finishing textile fabrics
2161. J. Shanks, St. Helen's, Lancashire—An improved mode of manufacturing sulphuric acid. (A communication from R. Von Seckendorf, Gera, Reuss, Germany)

*Dated October 10.*

2162. W. Crosskill, Beverley, York—Improvements in the construction of portable railways
2163. N. Prothéry, Lyons—Improvements in machinery for making lace
2164. H. T. White, Queen's-terrace, Hammersmith, and G. Roberts, Great Peter-street, Westminster—An improved mode of rendering hats, caps, and other coverings for the head, self-ventilating
2165. V. W. Hammerich, Altona, Holstein, now at John-street, Minories—An improved construction of buoyant mattress
2167. J. B. Jackson, Etna Works, Sheffield—Improvements in furnaces or fireplaces, and in the prevention of smoke
2169. J. Kershaw, Brixton—Improvements in the manufacture of wrought-iron railway wheels
2170. H. Crosley, Camberwell-grove—Improvements in the manufacture of waddings for cannons and fire-arms
2171. W. Chubb, Clifton, Gloucester—Improvements in the construction of beams and parts of ships, ships' masts and spars, and other like structures
2172. M. A. C. Millier, Paris—Improvements in the manufacture of paper

*Dated October 11.*

2175. W. H. Tayler, South-row, St. Pancras—Improvements in cartouch-belts or cases for containing cartridges to be worn round the waist or otherwise, calculated for arms of every description, guns, pistols, and other fire-arms
2176. S. Rogerson and J. Rogerson, Manchester—Improvements in the production of ornamental patterns upon velvet and other woven fabrics, and in machinery or apparatus for effecting the same
2177. R. Cruise, Manchester—Improvements in machinery or apparatus for stopping railway carriages
2178. J. Jackson, Belfast—Improvements in treating or preparing tow, so as to render it fit for drawing or roving
2179. T. Shaw and R. Dixon, Preston, Lancashire—Improvements in slubbing, roving, and jack frames employed in the preparation of cotton and other fibrous substances

*Dated October 12.*

2180. E. J. Seville, Brixton—An improvement in the manufacture of hats. (A communication)
2181. W. White, York-villa, Kensington-park—Improvements in the manufacture of manures
2182. J. T. Chance, Birmingham—Improvements in manufacturing articles from the minerals or rocks of the descriptions commonly called basalt or trap, sometimes rowleyrag and whinstone
2183. A. A. Routledge, Neath, Glamorgan—Improvements in the manufacture of detonating railway signals
2184. J. Hood, Newmilns, Ayr—Improvements in ornamental weaving
2185. A. Parker, New Milns, Ayr—Improvements in ornamental weaving
2186. F. A. N. Delsarte, Rue Croix Boissière—A new mode of and apparatus for tuning pianos and other kind of stringed instruments

*Dated October 13.*

2188. J. L. Hancock, Milford Haven—An improved machine for ploughing or working land
2189. Sir J. C. Anderson, Fermoy, Cork—Improvements in locomotive engines
2190. A. Dobson, Belfast—Improvements in looms for weaving
2191. C. F. Stansbury, Cornhill—Improved apparatus for heating buildings. (A communication
2192. G. Weeks, Dorset-street, Portman-square, and G. Pinner, Globe-road, Mile-end—Improvements in the construction of furnaces
2193. W. J. Barsham, Stratford, Essex—Improvements in machinery or apparatus for crushing mineral and other substances

*Dated October 14.*

2195. J. Harrison, Brighouse, York—Improvements in the bosses applied to mill-stones
2197. J. C. Haddan, Chelsea—Improvements in the manufacture of cannon, and of projectiles for the same
2198. S. Hjorth, Copenhagen—An improved magneto-electric battery
2199. S. Hjorth, Copenhagen—Improved electro-magnetic machine
2200. C. Holt, New-road, St. Pancras—Improvements in fastenings for the laths of iron bedsteads, couches, and other similar articles of furniture
2201. R. Pinkney, Long-acre—Improvements in bottles, jars, and other like vessels, and in the method of stoppering them
2203. L. Monzani, Greyhound-place, Old Kent-road, administratix of W. T. Monzani, late of St. James's-terrace, Bermondsey, deceased—An improvement in brushes and brooms—This is the same invention as that for which letters patent were granted to her late husband, 20th June, 1854
2204. J. H. Young, College-street, Camden-town—Improvements in brooms or brushing apparatus
2205. J. H. Pape, Paris, Rue des Bons Enfants—Improvements in the manufacture of boots and shoes
2206. W. J. Biseker, Birmingham—A new and improved and durable method of labelling bottles, and such like vessels or articles as require or may require labelling

*Dated October 16.*

2207. T. E. Moore, Great Titchfield-street, Oxford-street—Improvements in apparatus for sharpening knives, scissors, and other similar edged tools
2208. J. Bonnall, Spittlegate, Grantham—Improvements in apparatus for holding oil for lubricating purposes
2209. J. Thompson, jun., New York—Improvements in life-pres
2210. E. Barnot, Paris—A new machine for cutting files, which I cutting machine."
2211. W. Rossiter, Goswell-road, and M. E. Bishop, Cannon-st ments in the manufacture of pulp suitable for paper, pastebo papier-maché, and other like purposes
2212. J. H. Johnson, Lincoln's-inn-fields—An improved apparatus leakage or escape of gas. (A communication from E. A. Macpam
2213. W. Wain, Brunswick-street, Southwark—Improvements in the screw-propellers
2214. L. J. Wetherell, Compton-street, Clerkenwell, and A. J. Hoffstaedt, Surrey—An improved construction of pump

*Dated October 17.*

2215. W. H. Child, Providence-row, Finsbury—Improvements in the manufactu construction of brushes
2217. J. Coghlan, Craven-street, Strand—Improved mode of signalling on railways electric telegraph
2218. L. Cornides, Trafalgar-square—An improved apparatus for amalgamating the gold and silver contained in pulverized ores
2219. J. L. Cole, Henry-street, Salmon's-lane, Limehouse—Improved construction of portable drill
2220. A. Veal, Oxford—Improvements in the manufacture of boots
2221. A. Illingworth and H. Illingworth, Bradford—Improvements in machinery or apparatus for combing wool and other fibrous substances
2223. J. Dockray, Leeds, and J. Dawson, Holbeck, Leeds—Improvements in machinery for raising woollen cloth
2224. R. Green, Sydney-street, Brompton—Improvements in propelling vessels

*Dated October 18.*

2226. A. E. L. Bellford, Castle-street, Holborn—Improvements in breech-loading fire-arms. (A communication)
2228. E. Gessner, Aue, near Schneeberg, Saxony—Improvements in gig-mills
2229. G. Hamilton, Great Tower-street—Improvements in obtaining soundings
2230. J. Mason and W. Robertson, Rochdale—Improvements in machinery or apparatus for preparing and spinning cotton and other fibrous substances, part of which improvements is also applicable for shifting straps, by which motion is communicated in other machines
2231. B. F. Cooke, Boston, U. S.—Improved mode of caulking ships; applicable also to the rendering of roofs waterproof
2232. M. Wheeler, Newton-street, Holborn—An improved mode of consuming smoke arising from the combustion of fuel in furnaces
2233. H. A. Holden, Birmingham—Improvements in roof-lamps for railway or other carriages, and for parts used in connection with the same

*Dated October 19.*

2234. R. W. Winfield, Birmingham—Improvements in tubes and rods used in the construction of articles of metallic furniture
2235. B. Nicoll, Regent-circus, Piccadilly—Improvements in shirt-fronts
2237. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in the construction of grates. (A communication)
2238. J. Platt, Oldham—Improvements in machinery or apparatus for making bricks
2239. T. Biggart and A. Loudon, Dalry, Ayr—Improvements in regulating motive-power engines
2240. T. Higgins, Liverpool—Improved apparatus applicable to the ventilation of ships and mines and other useful purposes

*Dated October 20.*

2241. W. Marsh, Bywater-street, King's-road, Chelsea—Improved rocking and lounging chair
2242. L. A. Chenu and F. Pillias, Fontainebleau, France—Improvements in preparing animal substances
2243. T. Allen, Adelphi-terrace, Westminster—Improvements in applying electricity

*Dated October 21.*

2245. J. Smith, Gainford-place, Barnsbury-road, and F. S. Thomas, South-terrace, Walworth—Improved apparatus for steering ships and other vessels
2246. W. J. Smith, Stretford, Lancaster—Improvement in buttons
2247. W. A. Edwardes, Brooke-street, Lambeth—Separating iron or steel from brass, gun-metal, and all other metallic filings
2248. J. Jamieson, Oldham—Improvements in steam-engines
2249. A. G. Brade, Salisbury-square—Improvements in the manufacture of gas-fittings (A communication)
2250. B. G. Heywood, Green Mount Cottage, Dalkey, near Dublin—Improved apparatus for affixing postage and other stamps to envelopes, letters, and other documents
2251. W. Green, Howard-buildings, St. Luke's, and J. Pickett, Duke-street—Improvements in treating or ornamenting textile materials or fabrics and paper, and in machinery or apparatus for effecting the same

*Dated October 23.*

2252. E. Abell, Lambeth—Improved instrument to assist the hand in writing
2253. H. Hales, Brighton—Improvements in the machinery for propelling vessels
2254. G. Savage, Adderbury, Oxford—New or improved singeing-lamp
2255. A. G. Brade, Salisbury-square—Improvements in the manufacture of plate and thread for gold and silver lace and bullion. (A communication)
2256. J. Maddox, Thomas-street, Brick-lane, E. Gardner, Buxton-street, and G. D. Green, Weaver-street—Improvements in weaving fringes
2257. G. Simmons, Liverpool-street—Improvements in the construction of railway bearers and sleepers
2258. J. Penn, Greenwich—Improvements in the manufacture of the pistons, slide-valves, and stuffing-boxes of steam-engines
2259. J. Scott, Argyle-square, Edinburgh—Improvements in apparatus for facilitating surgical operations and teaching anatomy
2260. E. H. Marié, Paris—Improvements in the machinery for preparing, spinning, and twisting cotton, silk, flax, wool, and other fibrous substances

*Dated October 24.*

2261. C. Cowper, Southampton-buildings—Improvements in preparing to be spun and in spinning silk waste. (A communication)
2262. F. J. Bouwens, Mechlin, Belgium—Improved rotary engine
2263. G. A. Somerby and C. W. Fogg, Massachusetts, U. S.—Improved break apparatus for railway carriages
2265. F. C. Warlick, Suffolk-street—Improvements in generating steam
2266. J. Hopkinson, jun., Huddersfield—Improvements in steam-engine boilers and safety-valves, and in apparatus for indicating the vacuum in steam-engine condensers, in relation to the existing atmospheric pressure
2267. J. Welsh, Greenock, Renfrew—Improvements in extracting liquids from saccharine and other matters

*Dated October 25.*

2268. J. Rickhuss, Worcester, and C. Toft, St. John, Bedwardine, Worcester—Improvements in the manufacture of parian, porcelain, china, and earthenware
2269. J. Spencer, Bilston, Stafford—New or improved fence for railway stations, docks, and such other places as the same is or may be applicable to
2270. W. Henderson, Cannon-street—Improvements in treating certain ores and alloys, and in obtaining products therefrom

A. Stocker, Poultry, Cheapside—Improvements in the manufacture of tubes applicable to gas and other purposes, also in the construction of certain engineering machinery and apparatus, and the application of the whole or part of the same to, and other means to be used or employed in, the manufacture of tubes, also in the mode of manufacturing and the application of certain articles connected with or necessary to the completion of such or other tubes
2272. R. Roberts, Manchester—Improvements in machinery for preparing and spinning cotton and other fibrous substances
2273. W. T. Smith, New Hampstead-road, Kentish-town, and G. Hill, City-road—Improvements in machinery or apparatus for winnowing, washing, sifting, or separating corn, gravel, minerals, and other materials
2274. R. H. Hughes, Hatton-garden—Improvements in transmitting motive power
2275. C. Mather, Salford Ironworks, Manchester—Improvements in machinery for boring in the earth, and for actuating a hammer for driving tubes into the earth, and for other uses
2276. F. Lambert, Rue d'Enfer, Paris—Improvements in compounds to be used as cosmetics
2277. E. Pechenard, Monthermé, France—Improvements in roofs or coverings for buildings
2278. L. V. Helin, Rue des Douze, Apotres, Brussels—Improvements in the manufacture of paper from straw
2279. J. H. Johnson, Lincoln's-inn-fields—Improvements in circular loooms. (A communication from M. Poivret)

*Dated* October 26.

2280. W. G. Craig, Gorton, near Manchester—Improvements in the mode or method of consuming smoke, and in the machinery or apparatus employed therein.
2281. R. A. Brooman, Fleet-street—Improved method of obtaining alcohol from organic substances, and particularly from wood. (A communication)
2282. J. Healey, J. Foster, and J. Lowe, Bolton-le-Moors—Improvements in machinery to be used for drawing, moulding, forming, and forging articles in metal
2283. J. Eccles, Blackburn, Lancaster—Improvements in machinery for the manufacture of bricks
2284. C. H. Olivier, Finsbury-square—Improved apparatus for drying. (A communication)
2285. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in bleaching, dyeing, and preparing hemp and flax to be spun. (A communication from Messrs. A. and H. Six, Wasemmes-les-lille
2286. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in transferring coloured pictures, portraits, and engravings. (A communication from L. Muller and A. Widl, Vienan)
2287. J. Griffiths, Wolverhampton, Stafford—Improvements in the mode or process of manufacturing certain kinds of iron, and in the machinery or apparatus used in such manufacture; parts of which improvements are also applicable to machinery used in the manufacture of other descriptions of iron
2288. J. Dudgeon, Fenchurch-street—Improvement in rendering ships and batteries shot proof

*Dated* October 27.

2289. A. E. L. Bellford, Castle-street, Holborn—Improved mode of operating trip-hammers. (A communication)
2290. J. Turner, B. Holdsworth, and R. Beamer, Burnley, Lancaster—Improvements in power-looms for weaving
2291. A. P. Price, Margate—Improvements in the calcination and oxidation of certain metallic, mineral, and metallurgical compounds, and in the apparatus and means for effecting the same
2292. W. Aston, Preston, Lancaster—Improvements in safety or escape valves
2293. W. B. Wilkinson, Newcastle-on-Tyne—Improvements in the construction of fire-proof dwellings, warehouses, and other buildings, or parts of the same

*Dated* October 28.

2294. H. Adcock, London—Improvements in strengthening castings of iron and other metals
2295. J. Morgan, Kidderminster, Worcester—Improvements in machinery or apparatus for cutting metals
2296. G. Mumby, Hunter-street, Brunswick-square—Improvements in reservoir pen-holders, and other writing apparatus
2297. E. Lindner, New York — Improvements in revolving-breech fire-arms and magazine.
2298. J. P. Savouré, Catherine-street, Strand—Improved gold coin detector; applicable also for weighing postal communications
2299. C. Blake, St. Leonard's, Sussex—Method of preventing or lessening the injurious effects arising from collisions at sea, and on other navigable waters
2300. C. F. Vauthier, Dijon, France—Improvements in blowing-machines
2301. R. A. Brooman, Fleet-street—Improvements in centrifugal machines, and in driving the same. (A communication)

*Dated* October 30.

2302. O. Maggs, Bourton, Dorset—Improvements in portable steam-engines
2304. J. Wainwright, Birkenhead, Chester—Improvements in fitting up shops, offices, and other like places, and shop-fronts
2305. J. C. Hadden, Chelsea—Improvements in projectiles, and in machinery for manufacturing the same
2306. P. B. Chapuis, Lyons, France—Improvement in the harness used for weaving. (Partly a communication)
2308. R. S. Newall, Gateshead—Improvements in electric telegraphs. (A communication)
2309. J. H. Johnson, Lincoln's-inn-fields—Improvements in axle-boxes. (A communication from B. Laurent, Houécourt, France)

*Dated* October 31.

2310. T. F. Tyerman, Weymouth-street, Portland-place—Improvements in preparing hoop iron and such like metal surfaces used for bondings in buildings and structures
2311. W. Reid, University-street—Improvements in the manufacture of galvanic batteries
2314. T. Prosser, New York, but now of Birkenhead—Improvements in condensers of steam-engines and parts connected therewith
2315. J. H. Johnson, Lincoln's-inn-fields—Improvements in lithographic printing-presses (A communication from P. D. Vaté, Paris)
2316. A. Craig, Paisley—Improvements in the manufacture of railway wheels
2317. B. Blackburn, Clapham-common—Improvements in the manufacture of pipes
2318. T. Osborne and W. Eldred, Liecester—Improvements in apparatus for retarding and stopping railway carriages

*Dated* November 1.

2320. J. and W. Bradshaw, Blackburn—Improvements in time-pieces
2321. J. Rae, Alpha-road, New-cross — Improvements in machinery or apparatus for assisting in propelling vessels
2322. J. B. Robb, Boston—Improvemements in breaks or retarding apparatus
2323. A. V. Newton, Chancery-lane—Improved method of forging or swaging railroad carriage and other wheels. (A communication)
2324. H. Brinton, jun., and R. S. Weaver, Kidderminster—Improvements in the manufacture of carpets, hearth-rugs and other like fabrics
2325. J. Francis, New York—The manufacture of wagons, caissons, and other vehicles, applicable to transport military and other stores on land and water.

*Dated November* 2.

2326. J. Godge, Wellington-street—Improvements in machinery or apparatus for grinding. (A communication from A. and A. St. Denis, Bastia, Corsica)
2328. L. D. Dewey, New York—Protection against fire in vessels or buildings by putting out the fire without personal aid, or with very little, and against incendiary or fraudulent fires and ravages of vermin—He is the true inventor of it in part, and proprietor of the whole

*Dated November* 3.

2332. N. Topp, J. Holt and J. Partington, Farnworth, Lancaster—Improvements in hand mules for spinning
2334. E. Alexandre, Paris—Improvements in organ pianos
2336. W C. T. Chaeffer, Stanhope-terrace, Hyde-park-gardens—Improvements in treating the waste washwaters of woollen and other mills

*Dated November* 4.

2338. J. Adcock, Marlborough-road, Dalston—The novel application of the stem or stalk of the tobacco-leaf for various useful purposes

*Dated November* 6.

2340. H. Bordier, Orleans, France—Making alcohol or spirit from different plants and vegetable productions of a farinaceous nature
2342. J. Shaw, Dukinfield, Chester—Improvements in guns and fire-arms
2344. F. R. Ensor, the Park, Nottingham—Improvements in bobbin net or twist lace machinery
2346. W. Childs the younger, Brighton—An improvement in the manufacture of pipes and tubes
2348. F. J. W. Packman, Puckeridge, Herts—A method of compressing air in air-guns and an improved air-gun

*Dated November* 7.

2352. E. Hogg, Charles-street, Gateshead—Improvements in shot and shell
2354. W. H. Woodhouse, Parliament-street, Westminster—An improved meter for water and other liquids
2356. E. Simmons, Birmingham—A new or improved candlestick
2358. J. Bird, Chance's fire-brick works, near Dudley—Improvements in reverberatory furnaces
2360. J. Blaikie, Glasgow—Improvements in the manufacture of driving belts, straps, and bands for machinery

*Dated November* 8

2362. L. Glukman, Saville-street, Dublin—Improvements in effecting electric communications in railway trains
2364. J. Whitehead, Patricroft, Lancaster—Improvements in self-acting mules
2366. C. W. Siemens, John-street, Adelphi—Improvements in electric telegraphs. (A communication)
2368. W. E. Newton, Chancery-lane—An improved mode of constructing saws. (A communication)
2372. C. D. Cranstoun, Elgin, Moray—Improvements in coupling and uncoupling railway carriages and rolling stock

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PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

2312. J. C. Hall, Monkwearmouth—Improved windlass.—October 31
2319. C. Taylor, Holbeck, near Leeds—Improvements in mills for grinding corn and other substances.—November 1

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*Aberdare Local Board of Health.*—Mr. W. S. Rampling, of Liverpool, has been elected Surveyor to the Board. Seven candidates were invited to present themselves from a very large number of applications.

*Bury St. Edmund's Cemetery Competition.*—The Committee of the Burial Board have selected the designs of Messrs. Cooper and Beck, of London, from thirteen others sent in.

*New Midland Canal.*—Extraordinary as it may appear in the present railway times, a new canal is about to be cut in the heart of the manufacturing districts. The object is to unite Oldham with Manchester by canal; and the land for the purpose has been arranged for with the owners, and all the preliminaries agreed to. The design is to carry the canal from Oldham to near Middleton, where it will form a junction with the Manchester and Rochdale Navigation. The distance is four miles, and the ground so very unfavourable, that nine locks will have to be erected in that distance. It will run almost parallel with the Lancashire and Yorkshire Branch Railway line from Middleton to Oldham, and has been undertaken because of the alleged inadequacy of that railway to supply the wants of the manufacturers of those towns. It is clear from this enterprise that the war in which we are now engaged is not paralysing our trade and manufactures—is not diminishing employment.

*Discovery of Extensive Gypsum Beds.*—It is stated in some of the United States papers that Dr. Shumard, who is connected with the exploratory expedition under Capt. Marcy, in South Ameria, having reached the head waters of the River Brazos, had made the discovery of immense fields of sulphate of lime, one of which he had found means to measure at its outcrop, which he estimated at, at least, 700 feet thick. The waters of the river were excessively bitter, and the land unfit for agricultural purposes, producing scarcely anything, with the exception of the tree from which gum-arabic is obtained, of which the quantity was inexhaustible.

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END OF VOLUME XVII.