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, ABUDELL STREET, STRAND, LONDON.
INDEX.

Water supply, Glynn on, 186; Peckham, 177; Cheltenham, 296
Water power cranes, Armstrong's, 395
Water, scarcity for canal traffic, 364
Water seal action on cisterns, 388
Ways Servys—
Bragg, 68, 437
Richard Castle, 119
Birmingham, 443
Cotes, 285
Daventry, 258
Pusey, 347
Linn, 174
London, 613, 322, 325
Manchester, 34
Bob, 125
St. Thomas, Rother, 178
Sadler's, 177
Sadler's Patent, 441
Tottenham, 171

Water supply by railroad, 217
Water valves, Waddell on, 9
Water velocimeter, 236
Water wheel, Stann's, 392; Mains, 111; Boyton's, 27, 82; Smith's, 131
Waterworks, Manchester, 64; metropolitan, 378, 392; stand-pipe, Philadelphia, 387; pumping engine, Birmingham, 55
Wagons, railway, 52
Wagley's stuffing boxes, 67
Wheeler, on Australian emigration (rev.) 114
Wedge, new application of, 214
Wedgewood jointed drain pipes, Rover's, 60
Weight, parliamentary standard of, 316
Weights and measures, on uniformity, 156, 158
Wellington docks, 117
Westminster bridge, report on rebuilding, 253
Westminster palace decorations, 68, 557
Westray chapel, Torquay, 161
Wesley's saul fastener, 66
Westrup's conical mill, 111
Westgate's telegraph, 311
Wheel, fly, large, 87
Wheel, Adams', 817; Mains', 111
White, on symbols in art (rev.) 98, 136
White's sunbeams, 34
Wicks, on towers and spires of medieval churches of England (rev.) 9
Williams, on smoke prevention, 194, 255
Willow dock, 554
Wilson, on charcoal respirator, 316
Wilson, on smells of the U. S. 407
Wilson's patent propeller, 7
Window, dormer, Hill Hall, 460
Window sash, Girlish's, 464
Windows, glass on, 467
Wool, 436
Worcester, 257, 357
Wood, 390
Woodcock, 256
Woodcock, on smoke combustion, 466
Woodruff's saws, 228
Woodworth's machines, 381, 376
Wrexham gas and air engine, 68
Wright's quartz treating machinery, 209
Writing, illuminated, Rookin on, 467
Wyre light, 413
Yates, on uniformity in weights and measures, 256
Zinc, action of atmosphere on, 331; imports and exports, 318; works, Jersey, U. S. 349
Zinc-white furnaces, Roxel's, 237

LIST OF ILLUSTRATIONS.

Air pump, 225
Almshouse, 151
Baths and washhouses, 25, 257, 357
Bexon, 416
Bank, 45
Boat, 122-4
Boat, 168, 313
Boiler, 125, 206
Boiler stay, 220-3
Boring rock, 335, 400
Beer, 338
Bridge, 251, 316, 321, 336, 362
Buffer, 72
Bosy, 60
Capstan, 112, 373
Carriage, 464
Cemetery, 1, 429
Cemetery gate, 249
Chapel, 1, 611, 429
Chambers, 328
College, 41
Columns, 212
Copying press, 29
Crane, 224, 444
Crack, 225
Crossing, 33
Custom house, 185
Cylinder, 8, 57, 106, 272
Derrick, 224
Dock, 88
Door, 381
Dorrus, 460
Eaves' trough, 225
Engine, 56, 67, 145, 193, 217, 272
Entrance lodge, 249
Exchange, 25, 81
Filter, 304
Fire-box, 217
Fireplace, 184, 294, 289
Fisheries settlement, 253
Float, 15
Floor, 213
Floor, fireproof, 133
Foundation, 344
Furnace, 168, 152, 356-72, 399
Gasholder, 284
Gas-stoves, 185
Gate, 429
Girder, 122, 212
Governor, 258
Hall, 201, 288, 324, 393
Hammer, trip, 225
House, 128, 165, 246, 296, 328
Iron, 185
Hydraulic press, 128
Ironwork, 391
Jack, 128
Joist, 212
Key, 65
Lamp, 439-46
Lighthouse, 61, 344, 415
Lighting rod, 388
Lock, 64
Locomotive, 221
Lodge, 249, 296, 429
Manhole, 459-49
Market, 85, 161, 241, 393
Mess, 66
Meridian circle, 166
Meters, 166, 187-9, 216, 304
Moulding-box, 152
Ore crusher, 209, 288
Paddle, 152
Pile-driving, 373
Pipes, 245, 385
Piston, 67, 272
Plans—
Almshouse, 121
Baths and washhouses, 357
Boiler, 106, 122
Buffer, 72
Carriage, 464
Cemetery chapel, 1, 429
Chair, 43
Chapel, 1, 429
Colleges, 41
Crane, 444
Dock, 48
Engine, 193
Filter, 304
Fire-box, 217
Furnace, 153
Lamp, 439
Market, 439
Market, 161, 393
Mess, 66
Meridian circle, 166
Paddle, 152
Pile-driving, 373
Pipes, 245, 385
Piston, 67, 272
Plan—
Almshouse, 121
Baths and washhouses, 357
Boiler, 106, 122
Buffer, 72
Carriage, 464
Cemetery chapel, 1, 429
Chair, 43
Chapel, 1, 429
Colleges, 41
Crane, 444
Dock, 48
Engine, 193
Filter, 304
Fire-box, 217
Furnace, 153
Lamp, 439
Market, 439
Market, 161, 393
Mess, 66
Meridian circle, 166
Paddle, 152
Pile-driving, 373
Pipes, 245, 385
Piston, 67, 272
Rail, 15, 38, 52, 232
Ram, 373
Reconder office, 281
Reactor, 286
Retort, 333
Roof, 88, 384, 425
Sash, 66, 88, 424
School, 9, 15, 401, 460
Screw, 8, 888
Ship, 68
Skylight, 425
Slipper, 13, 33, 52
Smoke valve, 225
Smoke consuming, 365-72
Stand pipe, 337
Store, 153
Stove, 163-5, 204
Strut, 68
Stuffy-box, 67
Subway tunnel, 383
Survey instrument, 109
Switch, 33, 157, 149, 229
Telegraph, switch, 157, 149
Town hall, 224, 395
Warehouse, 425
Watercourse, 257, 357
Plough, steam, 105
Press, 29
Propeller, 8, 388
Paddle, 56
Pyramid, 48
Quartz machinery, 209, 288
Wagon, railway, 53
Washhouse, 25, 257, 357
Wheel, fly, 268
Wheel, paddle, 152, 313
Wheel, water, 181, 288
<table>
<thead>
<tr>
<th>Plate</th>
<th>Opposite page</th>
<th>Plate</th>
<th>Opposite page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. — St. Pancras Cemetery, Finchley</td>
<td>...</td>
<td>23. — Beattie’s Locomotive Engine</td>
<td>...</td>
</tr>
<tr>
<td>2. — Haslington Parish Church Schools, Lancashire</td>
<td>...</td>
<td>24. — New Market Buildings, Norwich</td>
<td>...</td>
</tr>
<tr>
<td>3. — Monkland Schools, Leominster</td>
<td>...</td>
<td>25. — New Washhouse, Frederick-street, Liverpool</td>
<td>...</td>
</tr>
<tr>
<td>4. — Liverpool Corn Exchange — Tynemouth Baths and Washhouses</td>
<td>...</td>
<td>26. — Milner’s Improvements in Steam Engines</td>
<td>...</td>
</tr>
<tr>
<td>5. — Carr’s Railway Crossings</td>
<td>...</td>
<td>27. — New Record Office</td>
<td>...</td>
</tr>
<tr>
<td>6, 7. — Church of England Training College, Cheltenham</td>
<td>41</td>
<td>28. — New Town Hall, Barnsley</td>
<td>...</td>
</tr>
<tr>
<td>8. — Pumping-Engines, Birmingham Waterworks</td>
<td>...</td>
<td>29. — Trumer Lodge, Down, Kent</td>
<td>...</td>
</tr>
<tr>
<td>9, 10. — Vulcanised India-rubber Railway Carriage Springs</td>
<td>72</td>
<td>30. — Taylor’s Water Meter — Improved Water Filter</td>
<td>...</td>
</tr>
<tr>
<td>11. — New Corn Exchange, Louth</td>
<td>...</td>
<td>31. — Bridge over the river Wien, at Vienna</td>
<td>...</td>
</tr>
<tr>
<td>12, 13. — Iron Roof, Smithfield Market, Manchester</td>
<td>...</td>
<td>32. — Façade of Chambers, New Cannon-street</td>
<td>...</td>
</tr>
<tr>
<td>14. — Dusauo’s Steam-Plough and Drill</td>
<td>...</td>
<td>33. — Kidderminster Baths and Washhouses</td>
<td>...</td>
</tr>
<tr>
<td>15. — St. Pancras’ Almshouses, Kentish-town</td>
<td>...</td>
<td>34. — Bower’s Engines for Driving Piles</td>
<td>...</td>
</tr>
<tr>
<td>16. — Dwelling-house, Coburg</td>
<td>...</td>
<td>35. — Doorway, Bocking Church, Essex</td>
<td>...</td>
</tr>
<tr>
<td>17. — Bellford’s Paddle-Wheels—Steam Boilers—Bernard’s Moulding and Casting</td>
<td>...</td>
<td>36. — Crossen’s Telescope Gas-holder, Philadelphia Gas Works</td>
<td>...</td>
</tr>
<tr>
<td>18. — Market-House, at Voornau, Vienna</td>
<td>...</td>
<td>37, 38. — Bradford Town Hall and Markets</td>
<td>...</td>
</tr>
<tr>
<td>19. — Theatre, Aix-la-Chapelle</td>
<td>...</td>
<td>39. — Iron Roof, Providence Magazine, Paris</td>
<td>...</td>
</tr>
<tr>
<td>20. — Iron Custom-House, Payta, Peru</td>
<td>...</td>
<td>40. — Chapels, Great Grimsby Cemetery</td>
<td>...</td>
</tr>
<tr>
<td>21. — Huttoon Hall, Cheshire</td>
<td>...</td>
<td>41. — Steam Travelling Crane</td>
<td>...</td>
</tr>
<tr>
<td>22. — Wright’s Quartz Crushing Machinery</td>
<td>...</td>
<td>42. — Glover’s Patent Improved Carriages</td>
<td>...</td>
</tr>
</tbody>
</table>
Dissenting Chapel.

Finchley.
ST. PANCRA'S NEW EXTRAMURAL CEMETERY, AT FINCHLEY

(With an Engraving, Plate I.)

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, No. 238.—Vol. XVII.—January, 1854.

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 872 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 instructions 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 design joint under.

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. Mr. Birch, having completed the ceremony of laying the foundation-stone, pronounced the following address. After inquiring 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 1500; 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 20 years has increased to 3856; 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 Cemetery, for which reason they were made to be the subject of the present inquiry. The question was 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 only be supposed that few, if any, 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 new 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 lot 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 no mark of distinction in the religious service, or for the piper as it may not be expanded for the poor. 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 curve and surmount; The king being placed in the centre, immediately beneath the spire. The door-way 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 city. This is formed and surmounted 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 a hill of a fine line. 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. The architect numbers, giving illustrations of the entrance lodge and gate, 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 Architets, Nov. 14th, 1853.]

The Public Museum at Lille contains a most precious collection of 1900 original drawings, of which 197 are attributed to Michael Angelo, 3 to Leonardo di Vinci, 66 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 Carracci, 2 to Correggio, 17 to Carlo Dolci, 10 to Fra Bartolozzi, 15 to Francis, 8 to Guercino, 5 to Girlandajo, 3 to Giulio Romano, 1 to Palma, 5 to Parmegianino, 6 to Poussin, 2 to Tintoretto, 8 to Titian, 3 to Albert Dürer, 3 to Lucas de Leyde, 1 to Rembrant, and 1 to David.

We give in this month's Number a series of 155 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 colour.

To some there are dimensions; others have the words a dischirente e no e misurato: sometimes the word antica is added. They consist of plans, sections, details, and some few elevations of various ancient and modern buildings. Among the former are parts of Titus, the Pantheon, a view of the Pantheon at Rome; of Augustus at Pula, in Istria; a plan and details of the Coliseum. Some seem to be plans of edificia or tombs, like those then abounding in the Campagna, and I find No. 439 to be identical with the plan of Plate 24 of Montouc's 'Sceita di varii Tumpietti 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 contemporary of Michael Angelo and uncle of Raphael; and many sketches of the Baptistery at Florence, and S. Giovanni in Fonte, S. Stefano, the present S. Stefano degli Angioli, by Brunelleschi, 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, araseques, pulpits, and groups of trophies of ancient Roman armour. The community of taste in the care of these drawings has 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. Burges, and other antiquaries call it, the Basilica of Constantine. It grew to such a size that Mr. Burg, as our friend, Mr. Burges, and other antiquaries call it, the Basilica of Constantine. It grew to such a size that Mr. Burg, as

favour 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: “(Questo una pianta d’una chiesa moderna no so di chi è stato fatto.)” The word “no” is left out, which is correct.

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, that Michaelangelo be the author of these sketches, that he should choose the ruin of a church by another, called by himself, and he knew not by what hand, when, from his constant residence at Rome, he must have had a thorough knowledge of the piles, 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 in the style of the first of the Christian ages; it is a small column to the niches, at one end of the nave, with which belong to “grotten, rather than to the whole house 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, and the doors, the arched windows, and the finial cornices, 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 “grotten,” rather than to the whole house 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, and the doors, the arched windows, and the finial cornices, 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 “grotten,” rather than to the whole house of ornamentation.

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, 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 Canova, the space is supposed to be occupied by a palatine arcade. As such a feature is irreconcilable 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 Canova, so as to be accordant with its size and disposition, maintaining its importance with the Temple of Venus and Roma immediately adjacent, and the other magnificent buildings of the Roman Forum, to which it is contiguous.

Our friend, Mons. Historio, to whom I sent a copy of this sketch, had great 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 tetrasyle, the other for a hexastyle portico, and the projection of the porticoes being respectively two and three intercolumniations. Our distinguished Historical 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 Brunelleschi, 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 it is in 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”—now and then commanded by the purest and by the most exacting, without any pretense of the utmost friezes and with a care of every minute, as of a work of his own. To this Michælagnolo replied by sending the plans for the work in a letter, written by his own hand, on the 29th Sept. 1555:


regard so many attribution. 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, and I am not sure that it is the same stair. It will do the work of a dream. I will describe it for you. Therefore, I have a number of oval boxes, each about a foot deep, but not of oval shape. The first and largest I placed on the pavement at such distance from the wall as the staircase I intended to build would allow; and I shaped it so as to diminish its size gradually towards the floor; the upper part of the stairs required for the door. This part of the oval boxes must have two windows, one at each end, that the sunlight may be admitted to the entrance. But the body is to be oval in form. The body of the building's height must be towards the wall. But from the center of the building, they shall be kept with the distance of a single stair that the entrance shall not be subjected to any part. And a man is a thing a thing to be laughed at, but I know well that you will find something suitable to your purpose.*

In a brief conversation on the subject, which I had with Mr. Vasari, the architect of Lille, he gave me as his opinion, that the sketch exhibited under the title of the Vicar collection was not the original idea of Michael Angelo; that he had lost the book, and forgotten this his first conception. But the sketch is equally in 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 the boxes alluded to by Michael Angelo, there are no side steps.

One object is the vestibule, that the intrusion upon the space of the floor, which has three steps, and 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 a slight change in Vasari's founded upon some vague rumour of Michael Angelo's arrangement might be more suitable. 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, as all the sketches of the Library, of the Cupidino 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 of the manuscript, 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 or four, in the number of strokes, 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 of the Abbey of St. Peter, 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 elegant art, should condescend to the task of minutely drawing the details of a octogenarian 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 we may admire the genius of Michael Angelo's generous nature. I am given to understand, that the master of the fresco or lesser degree of stucco, that had the Vicar 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 a connoisseur, assures my friend Hittorff, that he had traced the writing and the name of that which 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 Vicar 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 de' Medici, who was the first Duke of the house of Tuscany, at the request of Francis I., who, having heard of the decorations with which he was adorning the Palazzo del Tajo, desired to have an able artist to execute like works for him at Fontainebleau, and elsewhere. Primaticcio, according to Vasari, was the first who was called to Paris, and was the preserver of any few sketches for the French king, and we know how admirably he succeeded in the great and superb ballroom at Fontainebleau:

"King Francis, being much pleased with the conduct and proceedings of Primaticcio, sent him in 1644 to Rome, he having put the work, according to his letters, to the best and soundest policy. But, before attending to any other occupation, Primaticcio caused the greatest parts of those sketches to be made, when all succeeded so well, that they might be taken for the original intentions of his master in the work for Fontainebleau, where they were placed to the great satisfaction of King Francis, who was delighted with it. Francesco de' Medici had not long been dead, but he had been well served during the eight years, that Primaticcio had been with him, in the execution of that which was to be painted to be put in the palace, after it (in 1644 that is to say) his Majesty made him Abbott of S. Martin (at Troyes)."

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

Sr. Michelangelo puroqueste gagu destreir dezquese vos de vos ouvrages jadis fait en 1644 au Roi, il est venu faire le gage de vos autres ouvrages; les autres ayant ete faits a l'admiration dudit Roi. Puisque vous aviez fait pour lui plusieurs dessins, Prouy estoyez accustomez a essayer d'ouvrir nouvelle carrière en France, en ce est fort possible que ce soit ce qui a été exécuté à Fontainebleau, car il est possible que ce soit ce qui a été exécuté à Fontainebleau, car il est possible que ce soit ce qui a été exécuté à Fontainebleau, car il est possible que ce soit ce qui a été exécuté à Fontainebleau, car il est possible que ce soit ce qui a été exécuté à Fontainebleau, car il est possible que ce soit ce qui a été exécuté à Fontainebleau, car il est possible que ce soit ce qui a été exécuté à Fontainebleau, car il est possible que ce soit ce qui a été exécuté à Fontainebleau, car il est possible que ce soit ce qui a été exécuté à Fontainebleau, car il is possible that this Majesty made him Abbot of S. Martin (at Troyes)."

FRANCOIS.

No. 196.

DESMAREST.

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 the prosperity of a nation. This spirit has endowed Fontainebleau, Paris, and Versailles with the mastery productions of the greatest minds in Italy and France. The lower orders have their enjoyments in common with the princes, the nobles, and the land; and they grow up imbued with the spirit of that art, which is so mixed up with their holiday enjoyments, that it becomes part of the nation's proudest possessions, 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 Tuileries 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 accomplishments. So clearly defined and definite is the art feeling have those authorities been, who have hitherto had to provide for the palaces of our Sovereigns, and the palace 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 glorify his name and 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

---

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

---

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

---

5 This celebrated statue is still preserved in the Church of the Minerva, near the Pantheon, Rome.
successfully with the mere mechanical skill and industry of other nations.

But, in Angelus, 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 permissive, in his application to the subject we cannot but recollect that we owe to him the simplicity of detail, to which he reduced the cupola and other decorations of St. Peter's, which had been so badly corrupted by the immediate successors of Bramante, whose original conception had been lost. Vasari mentions 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 displease the Pope, who esteemed and favoured him so much, made a model in wood, seven braccia long (134 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. 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 ornament, ending with the great cornice; all of these works being so beautiful, that the court by the library 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 1748, 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 Master Giorgio—I can but ill write at this time, yet to reply to your letter I am forced; for besides the interest, which the architicture of the Papal city, of which you have so much written to me, has excited in my soul, it has also brought me a good letter, which has taught me to die, not only without regret, but with the desire to depart. I have had him twenty-six years, have ever loved him singularly faithfully, and now, that I have made him rich, and am not able to have him anymore, I am not merely separated from my sight, but I have also left any other hope, than of rejoicing 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 give it so much, as did the leaving me in this wretched world with so many troubles. Truly the last part of my life now goes with him, nor is anything now left me, except an ungrateful sorrow. And with that I bid you farewell."

I have been inexpressibly led, by the interest which attaches to the subject of the present paper, to give a full and minute description of that great artist, the 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 most intimate soul of Michael Angelo, and shows him with the tenderest regard as a King of artists, and the first and greatest of the most perfect and the most sublime in the whole 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. Whosoever they may be, whether the works of Michael Angelo, or of 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 bring with them an delight in giving their experience in seeing the most carefully 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 those architectural sketches, which well deserve the minutest attention from every lover of art.

Discussion.—Mr. Trzu, 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 Museum, in order to pass a portion of that time. Presently he walked into the Sala VIII, where the drawings are preserved 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, illustrating art, architecture, and antiquity. So long might Lille be visited, and so well did the collection deserve further notice, 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 them 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 untold ambition to reproduce the drawings appeared to him to be the first sketch of the great architect for the dome of St. Peter's with the double cupola. He was informed at Lille that Mr. 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 Mr. Wicar, which was exhibited with the drawings; and which, notwithstanding certain peculiarities of distortion, he said no doubt was dictated by himself himself, in 1796, from Milan:

"Armes d'Italie. République Francaise.


An 4 de la République—voi et indissoluble.

Bonaparte General du Comité de la Armée d'Italie.

A M. Wicar, peintre a Florence.

T'auras voulu lettre de 6 Prarial. Je 'n y a point reçu ces esquisses que vous m'avez envoyées.

Je vous envoie un livre de votre talent, objet digne de l'homme qui vous l'envoie.

Je sais toujours fort ais de pouvoir de vous être bon a quelque chose.

Bonaparte.

The sketches generally were singularly curious and beautiful; and he had so much struck with them that he had contemplated the architecture 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 the building; and a portico might 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, and were undoubtedly the production of some very clever man, if not of the great master himself.

Mr. Donaldson said, that he had intimated to M. Bensignat, 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 transcriptions of them; but that gentleman believed this would not be possible, insomuch 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. E. B. M., bore testimony to the extreme value and importance 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, in directing Mr. Donaldson's attention to them, he had insured its being much more ably done.

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 two hundred yards in length, a 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.
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 itself for the consideration of the members of the institutions, who prefer the establishment thereof 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 by shortening the space of time, and by establishing the railway 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 railways must, therefore, be consulted, by avoiding any cut 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 legates, has published a pamphlet, which he represents as being the result of 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 has given full and fair consideration to the views 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 we believe, too, that Mr. Cole is not out of the way. We think him, to all intents and purposes, a man of the best judgment, 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 and Industrial Museum of Painting and Sculpture, we fully expect that the funds will be provided, and we think it is not a competent body for the purposes we trust, that the Board of Trade should 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 extraneous 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. Sir J. G. G.  

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 the different opinion with Mr. Felix Summerly. 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 correspondence with the managers 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 point of Mr. Canals's 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 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 be implicated than government officials, but he does not refer to any 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 private bodies, and the results of individual enterprise. This has nothing to do with museums and galleries of art, which are not remunerative undertakings, nor have any religions or superstitious recommendations. Of course Mr. Cole brings in that successful government men who take a national exhibition of industry, and, as he says, would probably do so again, and that at the government give much countenance to 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 consequents, 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, the glass-houses, the walks divided into 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 a strong feeling in the country to promote a fall in 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 no such means of access to 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 any difficulty which should arise, as that of a bird, nestling in the mud, would be overcome by the 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 areas, the government are to be invited to lend or present to the company the National, Vernon, and other publiccolletions, and to “agree to pay a fair rent 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 business, which should properly be left to other speculators. If Mr. Cole, the Crystal Palace directors, Mr. Batty, or Mr. Charles Keen, 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 compete 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 glyptic athenaeums, mount Elzas, panopticon, gladiatorium, 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, Patents, Nov. 8, 1853.

The inventor states, that the proper place for the application of propelling force, to promote horizontal motion, is at the centre of gravity, and his, in other cases, is generally found true in practice—i.e., 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 motion in proportion to the expenditure of force, is 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 as right angles to the former, the resistance of which will be in a line with the force 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 the tapering blades of their tail, scimitar-like, and the broadest end, and the widest 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 the greater 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 resistance arising from density would be one-half equalised, and secondly, their blades being made tapering towards 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, like the beak of a bird, mean being suitably disposed 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 fol-
The propeller-shaft is traversed spirally by a broad screw-thread, on which the propeller (fig. 3) fits; while at work the action will keep it firmly down to the collar D; 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.

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.

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
WASHINGDEN SCHOOLS.
Tho' Holme, Arch.

West Elevation.

Half Section on the line A.B of Plan.

Plan.
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.

Engine, with 23-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 piercements, varying from 3 to 4 inches deep, of a rich, warm brown colour, with dressings of a light-coloured freestone. The walling is pitched, and 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 of the interior of the schools, 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 sculptured wrought-iron hinges and latchworks, 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£. The architect is Mr. Thomas Holmes, of Bury, Lancashire; the builders are natives of Haslingden. The parish church itself, which forms a background, is to be rebuilt.

THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL.


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 medieval times. Curious books and manuscripts have been hunted out—old relics stored—quaint carvings furnished 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 hand us forth with an open sesame, the 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 mother country 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 'Tories of the Medieval Churches of England.' This book has been long in preparation; indeed, the author states in his preface that it 'was commenced by him in 1849.' 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 realizations of this art; and it 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 our architecture, and the modifications it assumed at various stages are cursorily defined. This part of the work is evidently prepared more for the benefit of the uninstructed than the experienced reader; but, inasmuch as it is not devoid of technical expressions, and is totally unaccompanied by diagrams (that is, as a manual), it may be of general utility. 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 sing, with the Irish bard, each is the most perfect of all the rest. This is a frequent reproach for so the author hangs up on the Easy 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," etc. Of Perpendicular, "We would remark on its wonderful adaptability to all the requirements of church architecture, and its consequent tendency to be received into 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 style in which it is apt to assume. But when, as in the present instance, a subject so important and interesting, is taken in hand, and is to be fully, fairly, and systematically treated. 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 may be an error of judgment that, in the letterpress, the illustrations, which are the main features of the book, are 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 promise of possessing or procuring a second, 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.

Nora, 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 permit these short articles to lead 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 illustrated, 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 Stafford 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) are in another example in Grantham (Pl. 6); and of the turretted parapet (a not very common design), Kettering, Exton, and Uxbridge, 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 success. 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 most isolated 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 squadron in the west of the tower. The door below is exceedingly rich and effective. Though the double archway here introduced is not uncommon, the gabled and pierced exterior is a localism of which the same idea is traceable in Rushden (Pl. 25), as also in Uxbridge (Pl. 15). Swinehead, in the same county is, if we recollect, another instance.

The magnificent steeples 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 it would be 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.

Fairington 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-sounding 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.

Exton is a beautiful example, and so is Market Harborough, but the latter is not here shown to advantage. The spire, too, is not quite Perspectives correctly at the eaves, which gives it a large appearance, inconsistent with the original.
Walcot, in the same plate, we suppose is to be accepted as a specimen of that class of steeples of which Ewerby stands the preeminent type. The author, alluding to the latter steeple and others, states that they would have found a place in his list had they been needle-like Giltwistle in former periods, 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 front, which was its most interesting feature.)

Bythorne is a very poor affair, and yet within a stone's throw of Keystone. (See Pt. 4.) It is the most indissoluble 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 Ruesden on a separate plate; it is a most superb design and cannot be too well studied.

Thatcham is another favourite. Steeples are rare in Essex, and we are glad to see this has not been overlooked. Leotswithiel 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 described, this is a fault in the second volume 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 intrinsically 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 Bury and Almondbury); while the earlier splayed 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 Warrington, Hallaton, and Slaaford are such marked specimens. And again, St. Peter's, Aldwinkle, later in style. That of Warrington 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 acceptably 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 Glastonbury and its diminutive neighbour Holystone, without holding up to admiration either extreme.

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

In default of more palatable 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 in a title of the place. And, 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.


Is it 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 sciences are theoretically simple, their application practiced with 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 grasping anything to 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 the proposition of the small triangles on the line, etc., as, for instance, "To let fall a perpendicular from a given point on a line, "To form an equilateral triangle upon a given line," etc. 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, and are calling on our friends 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, etc., having a slight tint of colour on them makes them more easily understood.


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, in demonstrating in his former work on 'Road Progress,' and elsewhere, the rate of the 'passenger traffic,' and the effect of the system of management by which they may be subserved. 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, he may be found partially or completely introduced 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 first book of English, and in 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 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 "equalization 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 worked on the same system, and this mistake has been the source of much more loss than the good 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 on the outskirts of our cities to pay for the construction and working of express 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 constant jolts from bad joints, and from collisions with other trains travelling at various and unmeasured speeds. If light and light trains were used with corresponding rails in thorough order, and with no impeding traffic, these rates of speed might be maintained without the rails and without any immediate cost. But it would not do to permit any heavy domestic trains’ traffic on such rails. 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 might be constructed for fast light trains at the rates of 16,000l. per mile, including locomotives and rolling stock. 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 standard gauge. This convenience of running would be stated at the standard 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, cabinets or apartments for four persons each, for passengers wishing to be private; and open saloons would be provided for the gregariously disposed passengers would be arranged so well that that 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 water, lights, and mechanical heating, and, with 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 1,500,000l. it would require 75,000l. per annum to pay interest at 5 per cent.; or say 290l. per diem. Assume maintenance at 10,000l. per annum, that would be, say 28l. per diem, total 234l. The expense of trains would be 25l. each, going and returning a distance of 200 miles, with accommodation for 150 passengers each train. Four trains per day, with 72 passengers to each, or about 14d. 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 be required 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 2,600,000l.

"Four high speed trains, with 75 passengers each, going and returning the whole distance, at 21d. per head, say 380l. per mile, 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, assuming an average of 100l., or 50 journeys per annum each, could maintain such a line for their own use.

"The distance from Calais to Toulon is 800 miles, and the probable cost of a railway promoted by the Government, and the rails and material being brought from England, without duty, would not exceed 71 million. Four high-speed trains, with 72 passengers each, and 95 passengers each, at 2l. 10s. each way, or 1d. 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 Irwin in less than 12 hours, a distance of 4,000 miles 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 our capital, may be a question for the wealthy who desire it, but that this will eventually come to pass is no more problem. It is as sure a thing, sooner or later, as the transect between London and Windsor, or Paris and Versailles.

"At present the question is, are there wealthy capitalists enough in Europe to furnish $3 millions of money to shorten the distance between London and Toulon to a day’s journey, and 7 millions more to bring Calais within 30 hours of London, and travellers enough to pay interest and expenses for speed travelling at from 30 to 60 miles per hour, at 1d. 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 actual 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 necessities 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 analogous to each other, and be an industrial school on a large scale. They would break down the distinction between the rich and the poor, and open opportunities to all classes of men, and workmen, and be an insurance against fluctuations of employment.

"They must be rendered more available than at present for the storage and transport of grain. By establishing air-tight reservoirs of metal, or huge baskets, beneath the surface, grain might be kept, and when necessary, more easily and cheaply transported, and the country would be more able to support its people.

"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 grading, or of greater steepness than is common on ordinary railways. But it would be quite practicable to run engines capable of drawing 30 tons net at ten miles per hour up gradients rating 1 in 25.

"Let us then have 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 at the height of the ordinary driving. 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 condemned. The Great Western will be a success. 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 construct solid streets, of an 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 trade, allowing a width of four, or five feet, two or three feet 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 and would not exist, because there would be no materials for mending, and tracks 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 and more sanitary provision 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 tiered 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 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 or spelled rail, 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 economized from the ordinary way of using the rail, that is, as 80 lb. per yard with 'fish joints,' will be far more efficient than a rail of 70 lb. per yard without fish joints, by the equalization 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 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 rail 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 eighths of an inch 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 of using the rail, is, that the rail at half its length is spiked down to the cast-iron chair, and as it is so bedded, it is not crushed in the cast-iron chairs, as mostly is the case 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 3 inches in width, are used as single bolts 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, pieces of iron are placed in the rail channels, between the timber brackets and the rail, on 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 outfit, 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 portion of the neutral axis. Two varieties are shown one larger than 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 2 1/2 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 bearings 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 may be 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 square-shaped bolts and nuts dipping the edge of the bearing wings. The head or wearing plate 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 14 inch in widths, and they were gradually widened to 2 1/2 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 outfit is equivalent to all the chairs and keys, and one-half of the spikes."

"The joints are formed by plates of iron 2 1/2 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 checks 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 the 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 upper 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.'"

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.
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL.

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.

of which is, the air becomes rarified, 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 33 to 50 per cent.

Fig. 3.

ON THE SEWAGE OF GLASGOW.

Of 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 insufferable 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 carried 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 pipe. 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 smells are raised by the process, a perforated bed at 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 changed with D, and purified in a grand central 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

scribed, 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 done by two, and the work is more easily accomplished with the crane.

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 receiving, 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 movable shot.

Discussion.—Mr. Bevier (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. Cowen 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 6-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 crane in this manner, and the oblique crane which he had often 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 waggons 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. Cowen 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. Lloro suggested an octagon form for the purpose instead of the square, as he thought that the 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.

If 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 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.

The apparatus was ad
ted, and was al
c was raised too high.

Mr. Grimes 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 15s. or 20s.

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, Drochester, 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 Privity Council. The cost of erection, including fittings, desks, &c., amounts to 400l.

The building is of sandstone rubble-work (new red), with Bath stone dressings, from Messrs. Randall 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.
TRADE SCHOOLS.*

Nor 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 are aware, the original design was 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 Schools of Trade and Navigation.

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 tradesmen are required 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 780 tradesmen in the city, besides journeymen. Mr. Moseley observes, that the demand of the schools 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 probably most useful to the above class of mechanics, and that is general drawing. For the building trade, modelling and the making of models may likewise be advantageously taught. Geometry on the French system should be an essential 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, and to understand the most elementary of the new branches of practical work. Hence, 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 358 manufacturers and tradesmen, and these he ranks under the head of mechanical engineering, though 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 others.

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 practical instruction in mathematics, and in chemistry.

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, of the former of which are 300 pupils, and in the latter 800 pupils.

We consider it a defect in Mr. Moseley’s scheme that there is no provision for the department of practical ornamental 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 means of which the mind is capable of receiving—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 which are constantly made by our manufacturers and mechanical engineers.

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 benefited 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 workmen ranks, we may mention a workman who has not observed how his self-taught smarts have benefited him 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.

Mr. Moseley’s scheme as devised 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. Those who are trained for the artisan classes will 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.
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 a means 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 assist only one-half of the class, and hereafter evening classes will be established. It is held out that pupil teachers will be appointed by government endorsement, and encouragement be given to national school scholars by giving them exhibitions of 1s 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. 29th, 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 vogue of dogmatizing 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 inseparably influence the laws of 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 call your attention to a paper which I read here about a year ago, on the Methods of Painting upon Glass. 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 enamelled colour; by the enamel method, in which the colouring of the design is effected by using enamelled 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. One advantage of the thing, not open to 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 transept and north chapel of Brussels Cathedral—which works 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 medieval 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 coming in one plane, may be considered as occupying 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 medieval examples in this paper is made only for the purpose of illustration, and not with any intention of conveying any impression that they are to be the basis of imitation. It is 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 now existing in the form of pattern windows, is worth a moment's consideration 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 cinquecento examples, which, taken collectively, are perhaps of all ages closest to the least open to criticism. There is at least 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 medieval examples than trust to modern invention, permit me to say, that a more unjust imputation against the taste and skill of the 18th century never was made, or a more complete apology conceived for indifference 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 the injurious distinction and in the want of 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 pastime free from amusement, 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 unobscured in these works, and the mechanical construction of the window is in harmony with their design—the leadwork connecting the pieces of glass forming an integral part of the panes, and not the least undue attention was paid to the leadwork to give a satisfactory effect. It will 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. Returning 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. And it is the leadwork in these cases that is the least marked by the leadwork 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
the pictures of the 19th and 13th centuries. This, I apprehend, is owing to no less to the nature of the glass of which these pictures 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 pictures of the early period were able to retain the brilliant lustre of their picture-ground, unaccompanied by 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 filmy effect. We all are aware of the fact, that the shields of armor, the robes of the evangelists, with richly enameled and diapered 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 in later glass paintings. That such a simplification, as well as a more pictorial and watery material, must necessarily produce only a poor and filmy 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 13th or 14th century picture, as of its inanities with as much as by the disposition of light and 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 intelligently 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 glass employed is much more than in the latter, which, were it not for the beautiful but unmelting, and in the 13th century exceeded ½-inch in width. In cinquecento glass paintings therefore, the leadwork forms an integral part of the design, equally as in a 19th 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 allowed to, partly to the care taken to exclude the leadwork. But the surfaces of the glass, not being flat, the whole of the backgrounds, even the 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 minutiae 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 18th 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 19th 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. In my first sight through the 13th and 14th centuries, in the 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, or that they did not wish to associate their predecessors' rules for ensuring distinctness in a flat style. The inconsistency, not uncommonly 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 be placed, though manifestly intended, 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-
the 14th century, groups that, according to the usual fashion of the day, are surmounted with abrine work, look just like groups painted, with the force, benignly disposed by plants 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 incordination of their draperies, inattention to the principle of insulating them by means of the painted lines 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 paintings as inferior to the 13th, and the 15th century style as inferior to the 14th. They were indeed making efforts to get out of the 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 cinquecento 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 frequently arranged on the face of a panel, and are not 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 cinquecento, the gradations of colour are sometimes 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 14th 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.

In the 16th century the progress, 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 these pictures are more prejudiced by the character of the latter 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 distinguish 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 of even of 16th century painted glass, in the windows of a Norman or early English building from a distance too great for admiring 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, or whether blue, yellow, or red tints were used, 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 16th or 17th century, in reference to the window with the architecture of the 16th century. Experiments of this kind, and the experiments made in the 19th century, prove that the character of a 16th century building, when associated 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 the details of the window as displaying the 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 character of 12th century painting 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's views. He says in his 4th discourse, "with respect to colouring, though it may appear at first a part of the ornament, yet it is essentially much more grounded on that preceding 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 artificial 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. Grander effect is produced by two different colours, if they be opposed to each other, than 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 preceding principle of both must be adhered to; certain diaphanous tints, such as simple than monochrome: 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 originally: these distinct colours strike the mind more forcibly, from their 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 style of music requires; whilst in that which is relative to the passions, the passions are not the same as the other is 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, but little positive blue, the colouring being almost entirely composed with the grey and yellow tints in their purity; and another is scarcely more marked or sudden than 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 according 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 that can be said to have been associated with 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; if this be the case, it is not the Gothic, but the Gothic with a restraint. It should not be said that a Gothic building depends rather on its plan 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, gloomy and solemn as the aisles of a Norman building. The rule therefore might well apply to certain ecclesiastical buildings in the Renaissance style, and why it should not equally apply to certain ecclesiastical buildings in the Greek style: certainly these buildings, owing to the sim-
pleasure of their plan, do not possess the gloomy effect of a Gothic cathedral, but the extreme severity of the architecture imparts to them a certain air of gravity and solemnity, with which no other design is so perfectly 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 to diminish its appearance of gravity and solemnity, with which it might be supposed that architecture is principally composed of coloured glass. This, I freely admit, is a mistake; but, when I say that it is a mistake, I mean that it is a mistake to apply it to windows, and it is a great mistake to apply it to windows, as it is in the case of the mediaeval glass of the windows of the Parthenon, which were intended to be seen in the open air, 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 medieval buildings. For since I am perfectly sure that none but first-rate artists can design with effect for classical buildings, I must 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 mediaeval glass in the decoration of the windows of classical buildings, and some of the most original designs might advantageously be reproduced in painted windows for classical buildings, were it only by way of proving to the public, that 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 windows in the Palladian style of architecture, in which I would include all Wren's churches, and even all St. Paul's itself; for though 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 Greek 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 art. But by the word of notice these windows may be an embodiment of new ideas, which 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 wassery 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 19th 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, however formal for glass, may be turned into figures of sculpture in Pistoleti's Vatican, the most remarkable one is given in the 2nd vol, plate 3. 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 this period. These are 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-relied figures, placed in front of a sheet of glass, or in an ensemble, or in the secrecy of greater works; would find authority for the employment of well-relieved figures on perfectly

---

* D' "Vaticano descritto d' Ilustrissimo da Bramante Pistoleti." Roma, 1829; see also vol. 1, plate 1; and vol. 2, plate 4.

* "Contributions to the Literature of the Fine Arts," by Sir Charles Eastlake, New York, R. A.,
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL.

flat grounds. The use of receding pictures in painted glass in any buildings of any style has, however, been strenuously objected to, and 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. Second, that in making a picture in glass, one is senting 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 colours is opposed to that of the work of art; and the receding 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 other two 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 assume a precept. According to such a rule, Raphael was blamable 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 18th century, was far from exhibiting the comparative beauty of the medium in which it was made." He should, according to the above rule, have condescended to no means of representation less complete than what oil painting afforded. 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 transparencies (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 consideration of the means of representation may deserve attention to the most important attributes of art."

Under these circumstances, the confidence of glass painting is opposite 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 excellency of form such as are unattainable except in a painted window, the ground of objection to which I have addressed myself appears to fall 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 light of which is but such as 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 considered that a receding picture all round a room produces an ill effect; but pictures, that are receding pictures all round, 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; that is, such 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 the illusion of a picture hanging on a 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 the 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 once been considered a window or background, light, shade and perspective 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, indeed, may 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 these 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 then be applied to an interior of any building, or the 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 as nothing more than a copy, under the fond 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 fail short of the original in all real merit, and besides that, its production would be guided by similar 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 intelligence and taste. The intelligence and taste of the artist are 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 the artist, who is already occupied in considering the preparation of the paintings 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.

* "Contributions to the Literature of the Fine Arts," by Sir Charles Eastlake, p. 128.
A 19th century window, designed for a 19th 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 taste but from the basest, want of design in the attitudes of the figures of the 19th 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 the baseness of design in depth was interposed between us and the original. The artist was obliged to penetrate before we can fairly see it. I should add, that in designing a window for a 19th 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 has been so widely recognised in the glass paintings of the 19th 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 1350, 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 indigenous colours being as cool and almost, if not actually, as the rest of those of the 13th century, are internixed 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 in the next two or three hundred years of the 14th century, the character is internixed with a much larger proportion, so that this 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 stone-work, 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 glass, the mosaics, show themselves distinctly, as appears from the diagram I now exhibit. Here the principal lines of the stone-work diverge, like rays, from the centre of the window, whilst the principal lines of the glass composition form concentric circles. The stars, like effect, is seen in many other windows in the 12th 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, indeed, in any other church-building without mosaics—on the windows of the panels containing groups or single figures on stilted 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 material in any way, gives the Virgin and the Saints a form not 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, and the Virgin, St. John the Baptist, St. Peter, St. Paul, and the Patriarchs. I believe that I am speaking within compass when I say that his choice does not extend beyond these dozen single figures. Consequently monotony is inevitable, unless recourse is had to groups of figures. Here, indeed, the means of selection is almost unlimited, but there are obvious objections to the innumerable (Worship) groups. The danger should be averted by the precaution of having only one of the group of figures on the same window. For example, the following should be observed, "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 infrequently be extended beyond the limits of a single light. Upon the ground, of necessity, therefore, we may well juntify the carrying a glass
picture across a window, to a certain extent, irrespective of the bullions. 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 undeniable to me, artistry from the course of events, which were often broken through by the medieval 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 desolate ground more than once. The course of events, marks on the point of view. 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 I 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 the artist does not exceed the limits of conventionality—a fact 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 general public is a sufficient proof of that neither of those tints contradicts nature too violently; and that therefore 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, 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 that book was written that modern copies of the 13th century windows, besides being very raw in colour, were, owing to the extreme paleness of the glass then in use, thin and poor in effect; the most favourable examples never shone with the imposing air which an artist of old would have been content 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 flaws in without destroying the brilliancy of the material, and, at all events, of giving power to the work. And that since the manufacture of the 13th 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 had to permute, the great mass of universal opinion in 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.

**MANCHESTER CORPORATION WATERWORKS.**

Mr. J. F. Battyman has presented the following report, dated October 6, 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, notwithstanding 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 water line.

The embankment of the Torside Reservoir is within 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 Arndale 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 believe, been entirely stopped by the water in the Arndale 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 leakage which occurred at both works after they had been supposed to have been satisfactorily completed.

**PAVING AND SEWERING OF STREETS.**

Mr. John Frankish, 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 tabular sewerage has served further to strengthen his conviction of the complete adaptation of glass-lined 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 "sewerage 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 1848 being given to afford the means of Comparison with the Expenses of Subsequent Years.**

<table>
<thead>
<tr>
<th>Date</th>
<th>Total Area</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>From Oct. 1842 to Oct. 1843</td>
<td>32,412</td>
<td>18,684</td>
</tr>
<tr>
<td>1844</td>
<td>32,412</td>
<td>20,779</td>
</tr>
<tr>
<td>1845</td>
<td>32,412</td>
<td>7,807</td>
</tr>
<tr>
<td>1846</td>
<td>32,412</td>
<td>17,687</td>
</tr>
<tr>
<td>1847</td>
<td>32,412</td>
<td>6,311</td>
</tr>
<tr>
<td>1848</td>
<td>32,412</td>
<td>5,120</td>
</tr>
<tr>
<td>1849</td>
<td>32,412</td>
<td>7,994</td>
</tr>
</tbody>
</table>

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 slippiness 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 slippiness than Welsh blue sets.

**Whitney's Inlet-stand.**—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 a light-air tight small glass funnel, the neck of which reaches nearly to the bottom. By compressing the great mass 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.
TYNE MOUTH BATHS.
Ashpotal & Whichcord, Arch.*

CORN EXCHANGE, LIVERPOOL.
J A Panton, F S A, Architect
LIVERPOOL CORN EXCHANGE.

(With an Engraving, Plate IV.)

This 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 shares. A building was accordingly contracted on the north side of the street which was opened for business in August 1808. The plan succeeded admirably as a pecuniary speculation, the original 100 shares having advanced to the value of 350l. and 400l.

The increase of business, especially in the import of foreign grain, having led to the inconvenience of running of the market, a new building was designed by the late Mr. Pilkington, which was put up, 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, and 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, forming the upper portion of the plan 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 16s. 15d. 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 11,000l. The architect is Mr. J. A. Pilkington, F.S.A.

THE "PHENIX" IRON WORKS, Rhenish Prussia.

In 1844, a company was established at Eschweiler-ane, 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 Zollverein, but also in the neighbouring states, who employ 2000 workmen. The company, with a capital of about four million francs (160,000l.), 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 (56,000l.). 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 (4s. 9d.) per ton. The duty amounted to 18s. 7s. 6d. (14s. 10d.), 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 (1l.). 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 (4s. 9d.) per ton.

KIDDERS 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 gas, 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. Hauff, C.E.

The greatest 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 fulfills the condition of maximum resistance with a given weight of material, in proportion to the distribution of the weight, whether uniformly distributed or not, there is a curve of equilibrium; and a given amount of 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 flange 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, the inertial mass of material is not considerable, 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 considerations 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 bands, 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 loads, 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 fall in the direction of the diagonal. It is 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 superincumbent 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 shape of a bridge is 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, 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 $B$. Let $a B$ represent a unit in the distance $x$, will be in proportion to this distance, and will be expressed by $\frac{R}{a}$, and the sum of the resistances along the line $a B$, obtained by the usual method of integration, will be $\int \frac{R}{a} dx$, or $\frac{R}{a} a + a$. 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 $R a + a$, its moment of resistance at the distance $B d$. As the resistance of the triangle $\triangle G C$, is necessarily equal to that of the rectangle $\square G C$, the whole of the rectangle $a b e g$, will be $\frac{R}{a} a$. The resistance expressed by $\frac{R}{a} a$, 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 $R a$.

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 60 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, nothing but the effects of the variable load, and must be equal. If the area of each rod be represented by $a$, the two would be $\frac{a}{c}$; 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 $\frac{a}{c} b$, the two would be equal, and those produced by both, and would effect a saving of material equal to $\frac{c}{a}$. The rods in this case would require 33 per cent. more material than the plate.

If $\frac{d}{e}$ represent the material required in the rods of the end
The value of the expression becomes zero, or, in other words, 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 short 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, incompressibility, 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 is 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 \( v = n + w \); 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, the groove in the opposite cylinder being 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 opposite side of the cylinder to the starting position, will complete the full revolution of the cylinder upon the shaft.

ECHO'S WATER GAUGE FOR STEAM BOILERS.

Thus invention, at present under consideration by the Committee of the Franklin Institute, consists of a metal cylinder, of about 2 feet 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 nails, the inner openings in which are closed by hemispheres of glass, the convex portion of the hemispheres pressing against the nails; 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 and the boiler, and operate the bell-vent, 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 electro-magnet is set in the 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 electric current will not 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 to the only effective wire of the circuit. The object of the 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 the prepared track shuts the change, 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 change 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 be stopped until it passes the change. As such conductor, as he passes off the prepared track, places the circuit change 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.

Six-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 train of reasoning, I shall, so far as possible, confirm various respects, and as it is of importance that the public should not be misled by any of statements in questions of locomotive power, which materially involve the pecuniary interests of railway companies, beg the favour of your columns for the insertion of the following observations, with 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 F. 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 faults to begin with, that the fuel was entirely 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 chimney flue, and its performed stays for the admission of air, were not only unnecessary, but to 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 M.M. Ebneln 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 engine, though both air admitted, but the water was very 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 evaporatory duty of this fuel, on the one hand, and analysis of the gases in the smoke-box, on the other hand, pleasantry 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, 1-inch thick, may conduct the heat to the water at least as readily as the 1-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 proper and proper speed, and that the more water, as the proportion of steam, per horse-power, the more 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 grate-area 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 of course she contained only 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 "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-box, of grate, it did well to boil off 190 lbs. of water per hour, and this at the rate of only 8 lbs. 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 the quantity of water, at a much superior rate of speed; and there are many boilers of half the size which will do as much work as this leviantian, 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 this was not a trial of locomotives, 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 830 lbs. of water per pound of coke, while the large engine raised only 796 lbs. per pound of coke; and moreover, the fire was 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 fire-box; and as the steam was got up in the usual manner, but injuries of moderate, if not serious, at Wootton, 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-foot 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 a large diameter; there is no reason why, if it admits of a free exhaust, it sufficiently moderates the reciprocations, it moderates the direct strain 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 all correspondingly be reduced.

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 point, came to the singular conclusion 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 rate of 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
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, is a convenience 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 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 found; C D D, slide or pressure bolt, working vertically within the cylindrical head upon which the die or found 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 found 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; curved motion lever; ZZ, small shifting tappet or pawl, 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 pawl 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 found in readiness for the next operation. After the frame has traversed its whole distance, its motion is reversed by simply turning the tappet or pawl 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 1884.

Railways.
Aberystwyth, Nottingham, and Boston, and Eastern Railway (Extension of line into Nottingham).
Ayr and Maybole Junction.
Bagalmaston, New Ross, and Wexford.
Ballina, Wymondham, Coleraine, and Portrush Junction (No. 1).
Ballina, Baldonnel, 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 Cloon). 
Birr and Tyne (Extensions to Tynemouth, &c).
Birr 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.)
Camlock.
Carlisle and Silloth Bay Railway and Dock.
Carmarthen and Cardigan.
Caterham.
Clones and Carvan Junction.
Congleton and Riddulph Valley.
Conway and Llanrwst.
Cork and Bandon.
Cork, Blackrock, and Passage.
Cork and Waterford (with Branch to Ferrycar).
Darenth Valley (Extension to Sevenoaks).
Darlington and Barnard Castle.
Dartmouth, Torquay, and South Devon Extension.
Derbyshire, Staffordshire, and Worcestershire.
Direct Southern Railway and Thames Terminals.
Dover and Canterbury and Dover and Deal (East Kent Extension).
Dowlais (Extension, &c).
Downpatrick, Belfast, and Dublin.
Dublin and Wicklow (Extension to Woonerbridge).
Dundalk and Enniskillen (Branches to Cavan and Armagh).
Eastern Counties (Stazione Enlargement, Witham Branch).
East Lancashire (Dock Branch and Lines at Liverpool, &c.)
East Lancashire, Lancashire and Yorkshire, and Manchester and Southport.
Eastern Union (Branches to Wyndonshall and Eye).
Eastern Union (Woodbridge Extension Line, &c.)
East Suffolk.
Exeter and Exmouth.
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 Keying.
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).
Leicester-square Junction Railway and Southwark Improvement.
Leominster and Kington.
Llandilo and Newport (Extension from Llandilo to Llanegrid, &c.)
Llynfi Valley.
London and North-Western (Crews and Shrewbury).
London and North-Western (Haydon-square).
London and North-Western (Shrewbury and Newtown).
London and Oxford.
London and West Kent.
London, Brighton, and South Coast.
Londonderry and Coleraine (Castlelawson 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).
Monmouthshire and Brecknock.
Newport, Aberavon, and Hereford (Extension to Swansea, &c.)
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, and Wolverhampton (Graveley Loop Railway).
Oxford, Worcester, and Wolverhampton (Stratford-upon-Avon and Stonehouse Branches, &c.)
Perth and Dunkeld.
Portsmouth.
Potteries, Biddulph, and Congleton.
Rhu, Tyne, 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 (Leigham 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, Bourne, and Stamford Junction Railway, and Spalding Waterworks.
Stockport, Didsbury, 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, Parnborough, and Oxford.
Thames Embankment and Railway (London and Westminster).
Thames Embankment and Railway (London to West London Railway).
Torquay and South Devon Extension.
Tottenham and Hornsey Junction.
Tramore and Dunmore.
Tunm.
Yale of Towy.
Walls and Fakenham.
West End of London and Crystal Palace (Extension to Bromley and Parnborough).
West End of London and Crystal Palace (Branch to Wantsworth).
West Kent and Crystal Palace Junction.
Westminster Terminals.
Wexford and Wicklow Junction.
Wheaton, Chester 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.

Miscellaneous.
Abergavenny Improvement.
Abney to Ballater and Tarland Turnpike Road.
Accrington Gas and Water Works.
Albert Park.
Ashton-under-Lyne and Dukinfield Bridge.
Becup Improvement.
Bangor Waterworks.
Bannow Reclamation.
Beresford 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.
PARTICULARS OF THE U.S. STEAMER "GOLDEN AGE"*

**HULL—**
Length on deck ........................................ 270 feet
Breath of beam, at midship section above main wales ........ 45
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 .............. 522 square feet
Capacity of coal bunkers, in tons of coal .................. 600
Draught of water at load line ................................ 17 feet
Floor timbers at thwarts, moulded ................................ 18 inches
Floor timbers at thwarts, sided ................................ 12 "
Frame, distance apart centemeters ................................ 36
Masts and rig ................................................. Barque
Tonnage .................................................. 2376 tons

**ENGINE—**
One vertical beam ........................................
Diameter of cylinder .................................... 88 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
Breath 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 ................................ 164 inches
Diameter of smoke-pipe ................................... 8 feet 4 inches
Height of smoke-pipe ...................................... 41
Maximum pressure of steam in pounds ......................... 15
Description of coal ........................................ Bituminous
Consumption of coal per hour ................................ 14 tons
Area of flue and fire surface in boilers ....................... 5654 feet

**WATER WHEELS—**
Diameter .................................................. 84 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 x 3 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, concrete, 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 60° 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 per cent. 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; seedlac, 14 parts; coarse turpentine, 1 part; pyroglycol spirits, 40 parts.

Mixture No. 3, is composed of guata-percha, dissolved in coal tar, naphtha, or other suitable solvent, in the proportion of 3 parts to 1 part of each of the same materials.

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 plasters.—Newton's London Journal.

THE TIME BALL, EDINBURGH.

By Professor C. Piazz Smyth.

At the meeting of the Royal Scottish Society of Arts, on 19th Dec. 1883, 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. A letter was read from Mr. T. M. H. Wood, 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. Mr. Wauchope, after a few years, pursued the practical adaption 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 Maudsley and Field, had obtained by the adoption of a compressible 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 Baill 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. M. Mackdougal 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 Secretaries 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 authorities. But the necessity for the erection of a time-ball by no means decreasing with these official difficulties, as the representations of the Edinburgh and Leith Chamber of Commerce continued to show, he brought the matter forward again in 1846, 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. H. B. Rutherford), and the subject, immediately advocated it so powerfully in the Treasury, that it was forthwith 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 for 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 proceeded to 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 150 lb. The ceiling of the air chamber falls to first parts 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 near the nearly parallel walls, affords at last so convenient 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 to way up the mast; again; while, when fully opened, 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 first part of the piston, disengaged 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 loosen them than a magnet and well oiled wire. The piston acts 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 0·5 lb. will pull the trigger of, and drop the big ball, then 1·200 of 5 lb. would 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 motion 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 guata-percha, pass down the side of Nelson's Monument in a wood casing, and then underneath in iron pipes to the Observatory, where they rise through the floor, and are connected with the volatile 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 brass plate on which it is only just inserted in a few inches of the face of the transit-clock, beating its seconda 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.

Then, in the signal-ball apparatus, as fitted up by Messrs. Maudsley 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

Plan of an Acute Crossing

Fig 1.

A Chair.
B Chair.
C Chair.
D Chair.

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 drive the Observers by the galvanic touch; but, 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 arrangement of the instrumental adjustments by which the clock correction is 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 works. In most of our time-balls, 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 a practical instance, that the cost of erecting a metal frame into the spirit of a carpenter's 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 14.

Fourthly, in supporting in a similar manner with filling-pieces the upper flanges of switch-back and stocking 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 forging them in an entire piece, of the sectional form of the ordinary I-ring, 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-ring and filling-piece combined; 6. The formation of wing-rail and point-rail of railway crossings, by casting them in an entire piece, of the sectional form of the ordinary I-ring and filling-piece combined; 7. The construction and arrangement of railway crossings with loose blocks and wedges, in the manner above described.

INSTITUTION OF CIVIL ENGINEERS.
Nov. 29, 1855.—J. MEADOWS RENFREW, President, in the Chair.

The discussion being resumed on "Ocean Steamers," it was contended that the weight of a supposedly large vessel of 6,500 tons or even of 40,000 tons, to which it had been reduced, by a modified estimate, was inadmissible; that it would be manifestly impossible for any vessel to withstand such impact from a body of water; and if the position were admitted, it must be an impact of the metal form into the spirit of a carpenter's 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 14.

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 web of each chair shall be raised 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 chair, there is a fillet cast on the distance-piece, and also a fillet formed on the loose block, which fit into grooves or mortises 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, e, a locating block, or diaphragm-piece, in place of the usual block cast on the chair; f, f, is a wooden key or wedge for tightening the wing-rail b; and j, j, the key for securing the wing-rail b, loose block s, 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 wedge set in place, the wing-rails with the filling-pieces b, b, c, c, the point; d, the loose block or distance-piece, and e, e, the tightening keys or wedges.
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 was largely understood that the way in which used as the type, was built during the most depressed period (scientifically) of construction in H. M. Dockyard. Her dimensions were 175 feet long by 32 ft. 5 in. beam,—a proportion of about 55 to 1, and from what had been published it was evident 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 steam, with the object of economising in fuel; whereas the 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 30 lb. of coal 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 *Townsend*, without increasing her power, and by analogy it was only reasonable to presume, that if the proportions of the *Rattler* had been altered from 55 to 1, to nearly 8 to 1, there would be a still more striking result; 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, there was evidently no reason 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 sail from Liverpool and had been re-coaled, it 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 coal to the ultimate and distant ports by sailing vessels, who would convey them cheaper than she could do.

It must not be supposed that the meeting received with gratitude the results of calculations based on such a type as the *Rattler*, nor that the Institution could pretend to do more than add 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 vessels by various governments, 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 advantage 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 made in the *Times* of Nov. 22nd, 1856, from the *Liverpool Advertiser,* of Nov. 21st, which presented the result of this experiment in a remarkable form:

<table>
<thead>
<tr>
<th>Average number of days in 1852</th>
<th>Average number of days in 1853</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 200 tons to 300 tons</td>
<td>137</td>
</tr>
<tr>
<td>From 300 to 400</td>
<td>122</td>
</tr>
<tr>
<td>From 400 to 500</td>
<td>118</td>
</tr>
<tr>
<td>From 500 to 600</td>
<td>112</td>
</tr>
<tr>
<td>From 600 to 700</td>
<td>112</td>
</tr>
<tr>
<td>From 700 to 800</td>
<td>112</td>
</tr>
<tr>
<td>From 800 to 1000</td>
<td>103</td>
</tr>
<tr>
<td>From 1000 to 1200</td>
<td>103</td>
</tr>
<tr>
<td>From 1200 and upwards</td>
<td>91</td>
</tr>
</tbody>
</table>

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 was found the same.

But even with this evidence, it would not be wise to rush to the conclusion, that vessels of enormous size would be applicable in all circumstances, that which determined the velocity of the 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 steamer of 1200 tons would find any 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 be in 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, at first deemed, 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.

It appeared that a long period, since the *Rattler* 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 be required to ensure the *Great Western,* which, in order to do the Australian or the Indian voyage equally well. Such a calculation demonstrated that a vessel similar to the *Great Western* would require to be lengthened to 230 feet to accomplish that voyage. This showed that, in order to meet the demand of the existing trade, 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 among marine engineers, provided the structure was of iron. Ships of wood, on the contrary, were limited in size by the nature of the material, which grew, and not manufactured, and therefore the principle was of limited, if of a certain extent, and 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, whereas 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 magnitudes 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 linear 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. Secorday, did not strike the ship, but made its rise and fall in a gentle oscillation, each of which lasted sixteen seconds, a period of too long duration to produce great results; the short rolling, not to be measured, is 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 altitudes of these waves, that the decks could have been probably never broken. Such was the way.
steamers gave a mean average of 1.59 knots per hour for the last three years.

It was explained, that the average of 7.5 knots per hour had been derived from Admiralty returns, extending from 1845 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 that this could not be 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 naval ship called the "Bucephalus," which was built in Quebec in the year 1822, by the late Mr. Charles Wood, of Port Glasgow. Her extreme length was 804 feet; extreme breadth, 81 feet; clear depth, 34 feet; registered tonnage, 5,294 tons; and gross of timber 8,800 tons. The lines of the ship were 44 feet, and the beam 42 feet, the vessel being sufficiently deep to carry about two-thirds of her displacement. It was proved from the Quebec to the Isle of Wight in forty-eight days. It was due to Mr. Charles Wood to mention this remarkable voyage 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 changing those 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 beyond the worst expectations. It was 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 intended 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 from Battersea and Brixton, over an area of about 10 miles in length, with widths varying from 4 miles to 24 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 on the level of high water mark,—that it was a considerable extent formed of alluvial deposit, permeable to and saturated with water, and it was moreover subject to frequent flooding from the adjoining high land. For such a district the points demanding attention first of all were—through drainage; 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 ship.

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 circumstances, for thoroughly affecting both the cleansing of the sewers and the drainage of the district, by means inexpensive in themselves and independent of the necessaries of steam pumping machinery or of the caprice of ratepayers. It was described that existing sewers, even in very large districts as within 3 miles of London, and particularly 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 rapid natural floods that occurred, to facilitate this operation, by sinking several wells into which the land water might be allowed to flow, and the rain-water and drainage 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 little alteration.

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. Attaining the first objective, it was concluded that the stone sewers 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 utilise the action of the ebb and flow of the tide. The basin between that of Greenwich and the Greenwich marshes, which was stated to be 9 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 3 ships from Battersea to Greenwich marsh, having the same fall as the Thames at low-water neap tides; its invent being one foot below low water, and having a communication with the Thames at each end, so that water from the Thames could be conveyed into the basin, and being conducted into the river, or reserving 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 strait, and being conducted, 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 this 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 drain 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 at least 5 ft. 6 in. and 2 ft. 6 in. above low water, or nearly 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 flushed thence being fitted with flaps. These, it was contended, would 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 system of drainage was then examined, and from data afforded by Captain Vetche's sections, it was considered that they might be made available; the large proportion of 41 inches the common ditches (in 1820) had been proved to receive, but which some years since would have been deemed visionary.

December 12.—The discussion was resumed on Mr. Harrison's paper, and was continued throughout the evening. The complete system of sewerage introduced at Hamburg, since the great fire, by Mr. Lindley, C.E., was alluded to as a good instance of the efficiency of the plan of submersing the sewage in deep pits; and it was said that there existed a head of water like that from the Alster lake, which was 15 feet above the high-water mark of the Elbe.

The culvert through which the Frome passes beneath the flat, and flows into the Bristol river, was also described, and from those and other examples of the advantages of flushing sewers, that system was urged to be preferable to the labour and expense of pumping, which from depths below low-water mark, the ordinary sewage contents, without the use of water, is on an average of 7 to 8 feet.

It was also considered that any amount of steam-power which could be practically adopted. In fact the employment of steam-power for pumping out the sewage at low water, the opposition of the grounds, in most cases, and the liability to damage from accidental causes. It was also argued that the drainage of the fevers beneath the flat, was not analogous, as the water-courses were so large as to form reservoirs, whereas the pumps lifted water in a given, but strengthened period of time; and even not so as to avoid such bad 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 contented, was the plan which had been already adopted by Mr. D. M. and communicated to the Commissioners of Sewers, in 1849; and in a review of the systems proposed by Captain Vecht, the late Mr. Forster, and Mr. Basalt, the accordance with and the deviations from the original plan were fully commented upon.

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 the necessary sufficient volume to occur 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 on this occasion experience, confirmed the previous impression of the applicability of the pipes to house drainage only when they had rapidly 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 water remains stationary, and the distance it travels, and down the river with the ebbing and flowing tides; the experiments made on this point did not appear to be regarded as authority.

In treating the questions of detail, it was shown that the brick sewers served to increase the decrease along the banks, as had been experienced, and 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 bricks, that the little111 bricks. It would 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 duties 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 between 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 considering the Report of the Council for the year ending December 31st, 1849, and the address to 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 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.

A very 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 papers read during the 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 read by those who had been trained 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 offered 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, Caunter, and Coming; and four premiums to Books to Messrs. Richardson, Armstrong, Rawlinson, and Sewell.

Attention was directed to the engraving of Mr. Andrews' portrait of the Past-President, Sir John Bembe, to the portrait of Beindlsey, 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. The following resolution was moved by Mr. D. M., and carried: That the name of Mr. Couper, the late President, be added to the list of Presidents and Vice-Presidents, his name having been incorrectly prefixed, and erroneously assigned to him in the position of President, when the name of Mr. D. M. was really assigned, and named by the latter as the last act of Presidenthip, 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 deceased noticed were: they were Major-General W. G. MacNeill (U.S. Army); John Green and Tomaso Cin; Members—Col. J. N. Colquhoun, R.A.; and Messrs. E. J. Dent and G. Brashaw, Associates. The evening was spent in friendly conversation with 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 constructor, too early removed from a promising career; and the intelligent and efficient usefulness 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 debit for printing, yet the annual income now, for the first time, exceeded the annual expenditure; the surplus had increased from the accounts a large amount of arrears of subscriptions, and to erase the name of the defaulters from the register of the Institution.

It was shown that the cost of rebuilding the house of the Institution had been defrayed by the building fund, which repairs, which all repayments 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 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 attention of the Institution, 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 the Abstracts of the Minutes of Proceedings, showing the savings, 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 contributory contributions, to defray the inevitable expenditure of 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 accepted, and several members would contribute double the amount, upon a further contri-

The thanks of the Institution were unanimously voted to the President, Vice-Presidents, and other Members of the Council, also to the Auditors, the Scrutinizers 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. Hawkley, J. R. M'Clean, C. May, J. Penn, and J. S. Russell, Members; and H. A. Hunt, M.P., Associated 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 kingdom, and noted the regular employment of 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 purposes of professional credit, but the necessity entailed by it for fostering and sustaining the reputation of the Society, and for making its archives the repository 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 that the position of the Institution was that of a necro-

The new members had themselves, from the early days of the Institution, 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 during the period of his presidencies; and congratulated them on 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. W. Harrington’s paper, “On the Drainage of the District South of the Thanes,” 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.


Claim.—Widening and cutting 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.


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.


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 cores likewise furnish 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 whole, instead of reducing it into 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 circum axial 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 of the like kind, 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 lower end 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. Boydell.

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 by such a curvature or form, that the water at the upper part of the stream, leaving the garniture, or the 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 to 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 upwards from the disc, and making the lower sides of the parts of the passageways through which the water ascends, or passing 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, before entering the water-wheel, and retaining this converging into the wheel by about 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 next the next the gate, and fastening these parts together. The inventor in his claims considers the water ascending 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. Boydell.

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 when the garniture is raised by water running inward, 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 movable part of the garniture, if any be attached to the gate, so as to obstruct the motion of the gate, or movable part of the garniture. 2. The leaning or inclining of the floats, or buckets of turbines to the rim 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 of 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 stream above 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 resistance of the guide 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.

---

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, through the height of the fall varies greatly. 3. The combination of a cylinder, 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 arrangement 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 space between the wheels of water wheels, which the floats are fastened to, in which they move in the axis of the floats. 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 places 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.


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 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 toward the extreme occasionally, that part of the arm on which the block is most used soon becomes so worn that the block is loose, and jags. This can only be remedied by dressing up the arm throughout its entire length; for if all of the braces of the block were set up so as to make the block fit the arm throughout of the arm, it could not be moved towards the extremes. To remedy this defect in this arrangement, 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 gearings for variable cut-off valves.

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 working pressure, and also to increase the size of opening in proportion to the force of steam, and thus enable the engine to function 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.

Working the Values 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 communicating the same to the end 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-shaped that 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, the cam is transferred to the eccentric and brings the entire stroke into operation on the valves; 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 is of 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, and 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.

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 joints between the two middle panels furnished with inclined hook and eye, each of the middle panels having a ridge at the back 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.

Oxbridge 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 alterations. 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-northern 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 of the new work will be of a tentative character. The present contract has been let to Mr. John Holmes, of Bramham; the architect is Mr. Thomas Dickons, of Durham.
40. THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL


393. D. Be., Newmarket, railway, near Belchamp—Improvements in apparatus to be applied to the cutting of windows, doors, and windows, necessary to put such truck or carriages in use, independent of the locomotive engine.

394. E. Dimond, Dublin, gentleman—The use and preparation of certain solids and liquid substances for the destruction, purification, and desiccation of scorbutic and syphylisc solutions, and for neutralizing, decomposing, and absorbing toxins and acid gases.

395. W. G. Foster, carpet manufacturer, and R. Mills, designer, Darwin, Lancashire—Improvements in the manufacture of wool.-Improvements in yellowness, hardness, and beauty of wool. (A communication from W. G. Foster, Chorley, Lancashire.)

396. W. Austin, Holywell-street, Westminster—Improvements in the manufacture of rubber and vulcanized fibers.

397. E. Howland, Mississauga, near Belchamp—Improvements in apparatus to be applied to the cutting of windows, doors, and windows, necessary to put such truck or carriages in use, independent of the locomotive engine.

398. A. Disdale, Dublin, gentleman—Improvements in the manufacture of iron, brass, and copper for use in the construction of ships and other marine vessels.

399. R. J. S. Liddle, South-street, Finsbury—Improvements in apparatus for the preparation of iron, brass, and copper for use in the construction of ships and other marine vessels.

400. R. S. Boulton, Paddington, Lancashire, surgeon—Improvements of comminuting machines for the preparation of iron, brass, and copper for use in the construction of ships and other marine vessels.

401. J. C. Pemberton, Leeds, gentleman—Improvements in the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

402. N. E. Green, New-Georgiana, Leeds, chemist—An indicator of acid, applicable to railways and railway stations.

403. D. B. P. Gurney, Newcastle-on-Tyne, builder—Improvements in the manufacture of wood and timber.

404. W. R. E. Galway, West-street, Cheltenham—Improvements in apparatus for the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

405. J. C. Pemberton, Leeds, gentleman—Improvements in the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

406. W. G. Foster, carpet manufacturer, and R. Mills, designer, Darwin, Lancashire—Improvements in the manufacture of wool.-Improvements in yellowness, hardness, and beauty of wool. (A communication from W. G. Foster, Chorley, Lancashire.)


408. E. Howland, Mississauga, near Belchamp—Improvements in apparatus to be applied to the cutting of windows, doors, and windows, necessary to put such truck or carriages in use, independent of the locomotive engine.

409. A. Disdale, Dublin, gentleman—Improvements in the manufacture of iron, brass, and copper for use in the construction of ships and other marine vessels.

410. R. J. S. Liddle, South-street, Finsbury—Improvements in apparatus for the preparation of iron, brass, and copper for use in the construction of ships and other marine vessels.

411. R. S. Boulton, Paddington, Lancashire, surgeon—Improvements of comminuting machines for the preparation of iron, brass, and copper for use in the construction of ships and other marine vessels.

412. J. C. Pemberton, Leeds, gentleman—Improvements in the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

413. N. E. Green, New-Georgiana, Leeds, chemist—An indicator of acid, applicable to railways and railway stations.

414. D. B. P. Gurney, Newcastle-on-Tyne, builder—Improvements in the manufacture of wood and timber.

415. W. R. E. Galway, West-street, Cheltenham—Improvements in apparatus for the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

416. J. C. Pemberton, Leeds, gentleman—Improvements in the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

417. W. R. E. Galway, West-street, Cheltenham—Improvements in apparatus for the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

418. J. C. Pemberton, Leeds, gentleman—Improvements in the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

419. W. R. E. Galway, West-street, Cheltenham—Improvements in apparatus for the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

420. J. C. Pemberton, Leeds, gentleman—Improvements in the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

421. W. R. E. Galway, West-street, Cheltenham—Improvements in apparatus for the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

422. J. C. Pemberton, Leeds, gentleman—Improvements in the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

423. W. R. E. Galway, West-street, Cheltenham—Improvements in apparatus for the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

424. J. C. Pemberton, Leeds, gentleman—Improvements in the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

425. W. R. E. Galway, West-street, Cheltenham—Improvements in apparatus for the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

426. J. C. Pemberton, Leeds, gentleman—Improvements in the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

427. W. R. E. Galway, West-street, Cheltenham—Improvements in apparatus for the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

428. J. C. Pemberton, Leeds, gentleman—Improvements in the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

429. W. R. E. Galway, West-street, Cheltenham—Improvements in apparatus for the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

430. J. C. Pemberton, Leeds, gentleman—Improvements in the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

431. W. R. E. Galway, West-street, Cheltenham—Improvements in apparatus for the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

432. J. C. Pemberton, Leeds, gentleman—Improvements in the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

433. W. R. E. Galway, West-street, Cheltenham—Improvements in apparatus for the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

434. J. C. Pemberton, Leeds, gentleman—Improvements in the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

435. W. R. E. Galway, West-street, Cheltenham—Improvements in apparatus for the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

436. J. C. Pemberton, Leeds, gentleman—Improvements in the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

437. W. R. E. Galway, West-street, Cheltenham—Improvements in apparatus for the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

438. J. C. Pemberton, Leeds, gentleman—Improvements in the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.


440. J. C. Pemberton, Leeds, gentleman—Improvements in the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

441. W. R. E. Galway, West-street, Cheltenham—Improvements in apparatus for the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

442. J. C. Pemberton, Leeds, gentleman—Improvements in the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.

443. W. R. E. Galway, West-street, Cheltenham—Improvements in apparatus for the manufacture of cotton goods, particularly in the manufacture of cotton goods for the clothing of men and women.
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 a small space of ground adjoining Lady Pickerslee’s 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; this ensuring complete light and ventilation to the whole, and giving to the masters the means of quickly beholding 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 in to the boys’ room, secretary’s room, 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, opening 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 in-farmary, 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 colt 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 11,858l.

THE LOUVRE AND THE TUILERIES.*

This 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 anterior than contemporaneous with the new arrangement of the Tuileries.

The united edifices of the Louvre and Tuileries constitute one of the grand architectural monuments of the world, and represent all the great edifices of Luxor, of Thebes, and of Nineveh once were. We have nothing of the like class, though the ambition of the century may, before the dawn of the new century, 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 medieval 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 the abode of princes; they are one of the finest galleries of antiquities, and invaluable collections of the gems of modern art. Here, too, the yearly exhibitions are held of works of living French artists. Thus the name of the Louvre is that of a temple of art, and this is united with this 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 mass of arts, but on a site consecrated for twelve centuries remain the relics of the united edifices 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 Monnemon 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, there too have been the seat of 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 arts of art; but the halls of Westminster are reverence 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 communities of the United States, with the same power as they do at home in its inspiration, its authority, its example, its material community is still emerging into civilization. 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 Tuileries. The Tuileries was the imperial palace. It is found on the shores of the Seine, 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,

the kings of France have at length succeeded in bestowing on Paris one grand, crowning monument. The completion of this national enterprise, mainly 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 high plane of street construction, as will render the claim of Paris to the honour of being the most magnificent capital of Europe. The example of Paris has 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 project will cause foreign and luminous elements for this in London already. The Crystal Palace at Sydenham has stimulated a new class of enterprise, and the success 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 formation.

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 was limited to monumental objects, often incomprehensible, we have to notice a characteristic of the day—long-continued or connected façades and avensues. 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 trade 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 thoroughfares. New Cross-street will be connected with the main thoroughfare of the Roydon-street street will in time unite Cheapside and the Long-acre road. Victoria-street, Clerkenwell, and Victoria-street, Pimlico, will be avenues to other improvements. Although Cannon-street has entailed a cost of 800,000l, 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 real idea of the It is the construction of the Louvre on the river side, and likewise an eastern wing. In 1664, Catherine de Medici 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 1664, under Louis XIV, the construction and extension of the Louvre was put under the charge of Lemercier.

Louis XIV. employed the architect Leven 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 was partly adopted; but it is the result of additional 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 decoration of the whole was left to the last. 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 applying 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 Clesse, a distinguished French archaeologist. This gentleman was forced to retire at an early age, but managed to procure works of reference 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 lived for a time in England, from which country he 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 archeological 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 emigres, Clause 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 instigation of the 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 well be illustrated from the experience of England,—the indomitable application of genius, or the chapter of accidents alone opening a door to the Covelo 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 Colleges are hedged-in with restrictions; and as to the Sweyne courses and the nature of the students, one is reminded of the meek virgin who asks to be allowed to go to the streets and the little factory. 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 splendid institutions, and not only to students, but to mechanical institutions' and young men's classes, laudable as the motives of the founders are, they are insufficient substitutes for what is really required. We want evening colleges for gratuitous general and applied instruction. These we may wait long to see established, but what 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 Towneley collections, and professors so to do to its other galleries; but why should it not, as has been often suggested, take the advantage of the splendid gratuitous lectures on the collections under their charge?
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 actual remains from which their conclusions are drawn, if much, too, would archaeology gain by the illustration the treatises of the Museum would receive from Layard, Ferguson, Fellowes, Rawlinson, Wilkinson, or Hinckle. There the theorist could expand his system, there new illustrations of archaeology would be rapidly read by men non-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 Saul 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, the Royal Society, the Universities, the Laboratory, 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 legal coercion, so long delayed, is rendered necessary. 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 some other body, 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, archaeology, the oriental languages, and history. The only school of archaeology 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 nautical geology. He was given by the Government to the Great Globe in Leicester-sqaure. 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 monuments of our past, and our future, in monuments of palaces than those we so call. M. de Clarac obtained a great advantage from his appointment under the Mursats, as it led him to Naples, where a fruitful field of archaeological 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 mummy from 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 Vincenti 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 1805, by means of the 'Merit Fund,' established by his 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 subject 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 Tournai 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 enamelled images by the brilliant, cecaturistic 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 Malver Church; one of the heraldic badges from the East end of Henry the Seventh's Chapel; the Visit of the Queen of Sheba, and King Solomon, was another; and an interesting specimen from the Hammersmen'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 specimens in the Chatsworth, shewing the paintings of the Chapel 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 arms or drapery, &c., could not be better represented by outline than by shadow, especially as painted windows must be seen from a
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL

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, while others were in the form of St. George (the legend of 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 found that he could achieve this by the means of one man who had given a severe blow to the merely antiquarian view of the subject, and to the futility of direct imitation of medieval glass painting. Ward and Nixon, in their work at Westminster Abbey, were to be commended for not adhering too rigidly to the old styles, although they had 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. The style of St. Vincent de Paul, at Paris, possessed some of the finest specimens of such glass; but 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, although they were not used in developing the arts of the Chapel of Eton College, where the windows of Mr. Wille- ment 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 distinction, 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 relief, and from such works as the Bronze Gates by Giberti, at Florence, care being taken to render the figures important and the accessories subordinate.

The Rev. J. L. Pevsner concurred with Mr. Winston, whose object, it appeared, was to combine the merits of the glass of the 18th and 19th centuries, with a degree of art and beauty not then obtained; and in so doing he would not violate the principle that, when the artists got the best models and drew as well as they could, servility 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 exact 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 medieval 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. 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 planes was objectionable, because the metallic slips which formed their outlines were necessarily of the same thickness throughout.

Mr. Haskins 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 developed, were strongly advocated, and colored illumination 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 having been employed by his contemporaries.

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, but not obtrusive. The artist must select 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. Indeed, 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 millions 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. Winmore expressed the great pleasure and instruction he had derived from the discussion on the subject of his paper. Not being a professional 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 skillful treatment by the artist. A figure of St. Christopher, at Strasbourg Cathedral, of the 12th or 13th century, was nearly 14 feet high; but the drapery was broken in by the play 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 round style of glass painted was founded in material considerations; and he should 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 lack 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 be better pleased to have a party to 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 medieval art, and acknowledged not to know what to say about it. But his resolution to return 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. Ivy, Isaac Brown, and Seth Adams, jun. We thus particularise the committees 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 8 ft. 6 in. in height. The basement is in course 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, elaborate 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 5 acres, on which the base of the 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 Greek, consisting of a Doric basement, supporting, on its four fronts, porticoes of the Ionic order, taken from the example of the Erechtheum 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 fossilized 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 as the right and left, connected being immediately with it and the lobbies. Over these rooms the galleries are placed. Flanking the public hall private stair-ways 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 hill, from which 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 columns of this room 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 190 feet by 70 feet; height of ceiling from floor, 42 feet.

The forum of the House of Representatives consists of a semi-circular platform 3 feet in height, forming three steps, upon which there is a screen of East Tennessee variegated marble, 13 ft. 4 in. 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. 3 in. in diameter, and 10 feet in height.

The Senate chamber is of an oblong form, 26 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 Ercuffleum. 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 26 by 35 feet, in 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, panelled, and ornamented with devices; the windows are all double, divided by pilasters variegated with white, ovo, and cinnamon; 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 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 octagonal shafts of the same columns, in the style of the exedra. 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 superior quality, and was manufactured near Knoxville, East Tennessee. In fact, 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. LECLÈRE.*

MONSIEUR LECLÈRE, 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 own project was so remarkable that when his works at Rome the studies of the young pensionnaires 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 have given their names 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 Bâtiments, 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 Périer, was designed and executed under his direction. He was attached to the Institut, and was elected a 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 "Architecte." 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 his own inspiration at Ghent, where he was at pains to ascertain 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 28th of December last his remains were accompanied to the Cemetery 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 at the 5th 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 finished, he came out, he sat in a carriage, but it being 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 of 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, which had occupied the genius of French architects for two centuries. He had reaped the fruits of laborious and profound studies in the very highest department of the art of building; the problem which seemed to present difficulties apparently irreconcilable 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-
conceive rapidity, the outline of his grand design, which united all suffrages, and promises to render the Palaces of the Louvre and Tuileries 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. Dusilson, 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 four weeks ago, notice from 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 fine art of design and arrangement which is 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 your command." The Prince then explained a scheme that he had himself conceived and sketched, which he considered certain, and which he proposed, 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 carefully examined them in the manner in which his views had been carried out. Mons. Visconti then 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 develop 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 resolution was at once taken, and the appointment of the Visconti was made public, 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 prince, however, being, to its vast astonishment, that of the majority; "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 requisites were fulfilled by such a unanimity as 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 Mollière in the Rue Richelieu; the fountain on the site of the Palais Royal; the monument of the Empress Josephine to the west of the Church of St. Sever in the Cité 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 lately, 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 realizing 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 confess that his reception was quite new to me. He had a magnificent apartment, the ornament and elegance superior to any other private residence in Paris. The furniture was of a superb description, and full-sized cheechnoires of black ebony with glazed fronts contained most exquisite enameled of various sizes, dishes and vases of Raphael and Luca della Robia ware, or choicer of the French porcelain, and fine bronzes of all choice pieces, in fact, designed to breathe in 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 he is 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 not say how highly valued the grace and favor is 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 goliards for the floors, one of 70 feet span, which he purpose employing. At some future time I may perhaps give a history of the Louvre and Tuileries, note the various projects for their union, describe that of our lamented colleague, and explain some points of ingenious construction in this work.

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. Carat, 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:

"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 grandsiose work which fell to the lot of Visconti, it required, in addition to the completion of the architects, a 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 inexcusable activity—by a rapid coup d'oeil,—by a discernment as prompt as just, to render remarkable all those precise details, which, if they were, of able and intelligent artisans 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 glad by the brilliant success which was so long foretold, as if it were a dream of the State; nor did the architect permit his fair dream in this surpassing rapidity of execution, which astonished all Paris, and excited the wonder of those foreigners who fled hither. M. Visconti bestowed the utmost care upon the soundness of the foundation, the beauty of the exterior ornament, the 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 recognize 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 inadvertent expression which escaped M. Rochart de Fierney in his address; it is contained in these words: "It has been said with just reason that the loss of Mene Vioconsi 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 girdles over a smooth surface; and the exercise of skating, during which a man with little strength could glide with considerable ease, 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 iron 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. Légier 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 (laminair).

It is possible, in fact, to construct a special machine, with large pistons, long moving bars (mamodes) 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. Légier, 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. Légier'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. En.]

PERPETUAL VENTILATION OF THE GREAT PYRAMID OF EGYPT.

By G. W. Smirr.*

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 (Khufou or Saphis). 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. It is probable that this was 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 in 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, 2500 generations ago, it deserves our attention. An inspection of the accompanying diagram will exhibit the plan at a glance. A, B, C, shows the pyramids 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 when closed, 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 efficient, 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 consequences 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 multiples of other buildings springing up on every side, and invading the agricultural precincts of Warwickshire, Worcestershire, and Staffordshire. If these were to be continued, 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 public, we have reviewed in the present number a letter of Mr. F. L. M. J. A. J. L. J., of the Ordnance Survey, which contains many practical hints which might be turned to good account in national and local affairs. We have also 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 national and local affairs.

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 never 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 object to everything which is said of their 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 impasseable barrier which they place between themselves and the operatives, or rather machines (as 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 criticism of their various works as military engineers appear to be, they would be deprived of many valuable hints which at present are only tested; but as is often the case, the opinions of experts are never so much appreciated 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 forthwith, instead of waiting 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 8th 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 existence 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 of survey 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, 2nd 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 contrary to the production of clear and convincing 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 conversely through the greater part of the subject under investigation with tolerable success, but upon the slightest pause or change of manner, the witness begins to dodge away from the point in 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 never 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 object to everything which is said of their 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 impasseable barrier which they place between themselves and the operatives, or rather machines (as 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 criticism of their various works as military engineers appear to be, they would be deprived of many valuable hints which at present are only tested; but as is often the case, the opinions of experts are never so much appreciated 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 forthwith, instead of waiting 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 8th 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 existence 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 of survey 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, 2nd 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 contrary to the production of clear and convincing 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 conversely through the greater part of the subject under investigation with tolerable success, but upon the slightest pause or change of manner, the witness begins to dodge away from the point in view.

Much has been said by several witnesses respecting the applicability of the 6-inch map of Ireland for parliamentary deposit in lieu of the 2-inch railway map. The advantages of the 6-inch map 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 land, valuable, or pleasantly situated land will, if(scan) the Standing Orders on Standing plans, 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, can be sustained, whereas, in the case of railways, plans 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.

If there are 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 agriculturally," then the line of the proposed work will be included within the limits of the said deviation, upon a scale of not less than a 1-inch to every 100 feet.

In a densely-populated country, where the tenements are small and the houses and cottage 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 scale laid upon the probable utility 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 "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 laid 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.

The confused notions which this 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, consider the paragraphs 1431 and 1432, and 1441 and 1442, without arriving at the conclusion that these paragraphs exhibit an admirable specimen of what lawyers call "fencing"?

Such is generally the result, even when the most honourable means are used to avoid an accident at all hazards, any preconceived opinions. Take for example:

1439. "The one-inch map of the western coast of Scotland would not be sufficient to enable the Admiralty surveyors to put in their boat line from it."—Willing 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."—1441. "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 map reduces to a scale of 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 impel him upon the horns of a dilemma, from which he would not very easily nor very honourably extricate himself.

1470. Anwer. —"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 survey of the coast line, because that portion of the coast line which 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 a direct conflict 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 had no idea of the 1 inch scale being the surveyor's work at Southampton, we must really suppose that he was well acquainted with the whole modus operandi of the survey, and well qualified to direct the committee in their important investi-

gation. 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 would not involve the throwing overboard of the surveys of all or 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 one case than in the other; for in surveying the rural districts on the six-inch or any other scale we adopt 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 the close settled 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 is a great number of natural objects, as churches, 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 surveyors much more assistance than we have ever given them before. We can request the Hydrographer to furnish the Admiralty 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, whereby we will make the map 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 save them the necessity of enlargements.

We are aware that at present the Admiralty surveyors are 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 Fuejee 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 coast of the whole island of Great Britain at half an inch to a mile, 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; the he was appointed to be the great gun at the time of the sitting of the Committee. Is it possible he was stepping in front of his chief; or has he committed the unapproachable sin of knowing more about the matter than those above him in the graduated scale of rank, which also regulates the graduated scale of all 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 before the public:

1. That the six-inch scale be abandoned.
2. "That the system of contouring be abandoned.
3. "That the survey of Scotland on a one-inch scale be procured 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. The communication of the above decision of the Select Committee to the Ordnance threw the survey authorities into con-
sternation, well knowing that as the present generation of Ordinaries surveyors have been mechanically instructed in the several branches of their work every rollers, and in 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 utmost 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, the tillers of the soil, the assessment rates, sanitary purposes, the registration of deeds, or assurance purposes, show only some of the great and more general 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 follow:; on what bench, and not between the six-inch and the 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 the country." Or 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 work when in the first position, the bearing of the eight bears on the axle of the roller, producing rubbing friction, but when 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, the advantage of a larger roller than those formerly used, which has the effect of considerably 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, and those with fixed rollers more especially, from the top table always resting 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 useless in a very short time, unless the roller, which doubtless has 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.

To prevent the wheal of friction occasioned by these indentations, they cause also great unsteadiness, making the table rock, and thus clutter 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 properly made; this effect is often greatly increased the 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, or the same diameter, and turned 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 top continuous roller tending to force the rest of 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 heaving by which even new 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 curve; but these rollers have been found not to last, as 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 dirt 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.

Also, as usually constructed, have most of them two defects—namely, great extra cost of foundations, and unsteadiness and liability to defect; 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 turning the rolling over them being caused by the whole of the weight of each carriage passing over them, greatly 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.

Fig. 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 1/2-inch to 1-inch by the action of the knuckle-joint lever F; by this time the stud I, which is fixed upon the upper lever B, B, having traversed 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.**

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 L, 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 I, a weight is fixed to balance the weight of the table top to within a few cwt; 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 greatly 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. 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 its own weight. These 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 vessels to press equally over very light or of low bottom in 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 struts, forming a sort of frame, 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.

This 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 shipping, amounting to 4,825, in 1853, it amounted to $15,496 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 large dock, patented 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 large dock or patent slip was at the narrowest part of the river, about a half a mile from the town, on the north side of the river, which extends from opposite the Asylum towards Buncrana, called the New Land. This site affords an excellent foundation for marine works, the beach being composed of rock, covered towards lowwater with mud, and consisting of a slight deposit of silt, and having a rise of tide of from 6 to 8 feet, together with also a rise out of 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 "Scow" type of dock, both of which have been used 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 half-way between the roads leading to Buncrana and Portsalon; thus cutting off from connection with the harbour of the only remaining available space for the extension of the Port of Londonderry, as has been done by the "Gridiron" dock, the railway at the tail of the river, and by the Enniskillen Railway above the Bridge of Derry. The Londonderry Improvement Scheme proposes to occupy the slop 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 Rossie's Bay, Culmore Point, and the inclosure opposite to Thornhill. The quays recently constructed by the Coleraine Railway Company would require to be extended, and the power of conserving and improving the Lough Commissioners of the Admiralty. The estimate for this extended scheme, including 10 per cent. for accidents, &c., would amount to—

1. Quays from Londonderry Bridge to Patent Slip, inclusive of dredging in front of 10 feet below low-water mark........... £28,000
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 Rossie's Bay to 13 feet below low water... 10,000
5. Excavation, &c., at Culmore Point ............. 10,000
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 adopted 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 we have obtained by 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 refer, [277] in general, took place at the commencement of the extensive alterations in the Rue de Rivoli, in the spring of the year 1832.

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. Thounes, and the other appearing to be that of any one who may have occasion to execute it. But in 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 Thounes" 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 0.060 metre in the metre or of 1 in 200. They are placed at the distance of 1:00 metre (or 3 ft. 3 in.) from centre to centre, and are united by interties, formed of flat iron bars, fixed at the same distance of one metre 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 interties, between the joist and the band, and the transverse tie is formed.

The fantsons are light iron rods, from 8 to 10 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 joists 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 grooving. 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 grooving composed of the coarsest quality of plaster is then poured in upon it, and running in between the lower portions of the framework, it stops a little under the board, and forms the ceiling of the room below, which one coat of fine plaster serves to finish. The plastering thus applied is from 3 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 8 to 9 inch square, bent at the ends so as to dip the upper flange of the joist, and crooked downward 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 will 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 fantsons or light iron rods lying parallel with the joists are laid on the interties, and the grooving performed in the former method. The floors then the 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 the advantage that it is more easily 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 height of the joists could be correspondingly lowered. The iron, being assumed to have the necessary strength to take the bearing.

As I have elsewhere observed, the grooving 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 4 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 grooving to fill in the interstices. 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. Thounes is much more extensively employed 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 cheaper, and on this account the other method 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 indestructible as any others, where 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 tariffs should be found a correct guide to the expense. The building trade, as so much trade on the Continent, is run by 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 the materials used are very much dearer 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 grooving in England must therefore be considered as double that of Paris.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ft. in.</td>
<td>ft. in.</td>
<td>inches.</td>
<td>inches.</td>
<td>lb.</td>
<td>$$.</td>
</tr>
<tr>
<td>10</td>
<td>0 to 11 6</td>
<td>4</td>
<td>71</td>
<td>570</td>
<td>219</td>
</tr>
<tr>
<td>11</td>
<td>0 to 12 6</td>
<td>4</td>
<td>71</td>
<td>570</td>
<td>219</td>
</tr>
<tr>
<td>12</td>
<td>0 to 13 12</td>
<td>4</td>
<td>71</td>
<td>570</td>
<td>219</td>
</tr>
<tr>
<td>13</td>
<td>0 to 14 12</td>
<td>4</td>
<td>71</td>
<td>570</td>
<td>219</td>
</tr>
<tr>
<td>14</td>
<td>0 to 15 12</td>
<td>4</td>
<td>71</td>
<td>570</td>
<td>219</td>
</tr>
<tr>
<td>15</td>
<td>0 to 16 12</td>
<td>4</td>
<td>71</td>
<td>570</td>
<td>219</td>
</tr>
<tr>
<td>16</td>
<td>0 to 17 12</td>
<td>4</td>
<td>71</td>
<td>570</td>
<td>219</td>
</tr>
<tr>
<td>17</td>
<td>0 to 18 12</td>
<td>4</td>
<td>71</td>
<td>570</td>
<td>219</td>
</tr>
</tbody>
</table>

The accompanying table is translated from a tariff of prices circulated by M. Thounes 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 evidence of the experiment which I had always intended to make. I have, however, the satisfaction of knowing that these experiments have been made; but perhaps, the general adoption of one or other of the methods may be received as the best guarantees 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 Corresponding 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 arrangement and proportions are, at least from our point of view, the same we may be sure will be found in the many cases we see of the progress made in this department of our art, and that we may be able to derive some assistance from 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 demands of the time; and the opportunity offered to the construction 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 embrace as little prejudice as our neighbours in our inquiry into the merits of that principle, which concretely has done its part to invest their newly-erected buildings with stability and refinement worthy of the age.

The Revue Generale de l'Architecture contains the following experiment, made upon a floor 16 feet span (Système Vaux) the joints being only 3 inches in thickness, and the camber in the 16 feet. Upon the grouting being filled in the camber was reduced to 1 inch; upon the floor being loaded with 1000 lb. per yard super, it was reduced to 1/4 inch, and after forty-eight hours pressure again decreased to 1 inch, the deflection of the load being 1/4 inch; the weight being removed, the floor resumed a camber of 1/40, having lost 1/20 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., referred to a paper read by himself in 1840, 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 centimetres, 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 practise 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 case, where plaster of Paris was comparatively expensive. The configurations 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. Fowler alluded 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 1/4 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 horizontal plane. The window openings were filled with stone, and 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 platter, mentioned by Mr. G. R. Burnell, he could not understand how the abutment above would press down the floor, when the joint was a flat centering, or a sort of flat centering was fixed and secured below the joint, and the plater was fastened 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 plater then 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, and also used a drying-room, and was not 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 construction of rolled plates, which were successfully at the Butterly 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 deficient joint broke, and fell down vertically, striking out one joint in every floor 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 space of 10 to 20 feet, in a coach manufacture 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 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 rigidities to which he had referred, it appeared that the French system 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; it could not be limited by an intention 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 house in consequence of finding that the floor with joints and be 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 resistance of the iron erected 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 the size of 8 cwt., the difference in the weight of the flooring; and, therefore, if the French floors were safe with 5 cwt. of iron, their 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 flooring. His plan, in a floor of 20 feet span, would be 7 inches from the flange of the joint, the whole substance being 18 inches thick, including 3 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-puddled floor.

Mr. C. H. Sarrin stated, for the consideration of the members, that the fact 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 5/8 inches of ordinary mortar next to the girders, before using the plaster of Paris, might be desirable.

APPARATUS FOR ASSAYING PRECIOUS METALS.

J. A. STAUFFER, 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 contemplated 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 unswerving study and labour Mr. Stauffer overcame these difficulties, in 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 annullar 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.

This 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 surrounded 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 grams, it will be necessary to stop the dial-band 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 a brass for the purpose. 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 grams, and the cylinder show 11, then the result will be

\[ 39 - 11 \times 24 = 17.23 \text{ proof.} \]

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

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.

The injection-valve is also made upon the double-best 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 pinn. This detent comes into action upon the engine when making more than its usual length of working strokes, 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 28 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 12 inches diameter and making 6 feet stroke.

The feed-pump W, is of 6½ inches 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 I, I, and the delivery-valves M, M, (shown enlarged in fig. 6) are of the double-best 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.

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 8 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 200 tons.

Upon the first delivery pipe joining the air-vessel is fixed a safety discharge-valve of 8 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 lever or walking-beam R, R, fig. 1, is 30 feet long, casting in two places, each 3 inches in thickness, and the depth of it in the middle is 6 feet, and at the ends 2½ feet. Each of the plunger-blocks has saddles of cast-iron between them, and the wooden spring beams S, S, which latter are 30 inches deep and 90 inches wide, of the best Memel timber, and formed 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 CIVIL ENGINEER AND ARCHITECT'S JOURNAL

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 engine.

The water lifted by every stroke of each engine is equal to 180 gallons, or 1800 gallons per minute, and 106,000 gallons per hour, weighing upwards of 400 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 perseverance; 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 in life. It may be added, that both were equally esteemed and respected, whatever of unblended integrity both had 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 formal qualifications, and in his 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 patronages and friends was the then Mrs. Sneyd, of Ashaunb, 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 Shewell, and his father may be mentioned as other constant friends, 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, Iham Hall, near Ashaunb, and Eton House, in Warwickshire, which he built for his respective owners, after designs of Shaw and Blore, may be quoted as specimens of first-rate execution. In another line, a bold and original conception of great simplicity, withal, he accomplished a very remarkable work. The lofty tower of Wesley's Town 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 gooses 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 "Grovesnor Bridge" over the Dee, at Chester (so called from her present Majesty, then the Princess Victoria, at its formal opening in 1833), 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 Mr. Trubshaw was 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 £6,000, was sufficiently formidable for the work attended with so many possible yet indefensible hazards, at a day when the gigantic contracts of later times 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 to whom it was not afforded the least prospect of adversity now and then, and curbed, (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 payments on which they might depend. Trubshaw was more than once reduced to very disagreeing straits. But he was no vain theorist or random pretender, neither 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 inversion 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 I cannot omit to introduce them here, in which, as already remarked, so much of his genius and integrity appeared. 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 three score 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-fortunes in the foregoing respect, the health was accepted with good will and good grace. But, from his habitual sagacity 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 named by her present Majesty, then the Princess Victoria, in out, where my profits would be. However, I have paid—or shall pay
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 attention which 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 told
With more gallant modesty released?"

Mr. Trubshaw's age and comparatively falling 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, on the angle stone walk which should be several times longer than Olaus'psara'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 1815, which he had undertaken that of Mr. Shuck, 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 instruction. Order was a great feature in 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 distressed was he to wait on those whom his exertions happened to prove unsuccessful at the moment. And other like traits of honesty might be added in abundance, did such mere personal anecdotes belong to such general outline of character as the present.

In conclusion, 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 1815, some little memorials of their wedding 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 unsailing industry. He died calmly, on the 10th Oct. 1842, at Little Haywood, Stafford, and 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 inimitable fashion, that lamentation of circumstances of such weight—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-ahead days, when steam and even sailing vessels are rivalling the speed of our fastest railways, 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 discoverers and inventors; yet it is a subject of great importance, and, at the same time, of great interest, and full of the development of scientific thought.

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 become the sole mistress of the waves, she has been and is still in use for the purposes 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 for cornelian beaks wholly incompatible with the nature of those 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 purposes for which it is used and presents the least objectionable features; but notwithstanding this 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 make it a heavy chain. Now when we consider that the sea when not opposed is harmless,—as witness, the bottle 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 position of the vessel's body is to 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 evidence is very evident, and it is this which causes them to break their cables. A buoy, having a displacement of about one ton, is moored by a ½-inch chain, calculated to hold a sailing vessel of 130 tons but only; yet this small body will break such a cable. Buoys are generally moored from their lowest part. The lowest part is, in different positions, 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 the chain. It is this lever which, by further construction will exert itself 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 to two break a 6-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 beauty may be best attained, and nature being a wise and all-wise, have availed themselves of the beautiful lines which flaws 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 levees, the floating bars, the aquatic plants; especially to the magnificent cavi of the Victoria Régia 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 and 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 length. A circular vessel of this size and shape at first sight would 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 windward, and the wind from her head. In a circular vessel 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 inconceivable. 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 and the weight of water above the 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 as well as from the fact that a vessel constructed in this manner and with a single support 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 other side 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 34, 1851.*

These improvements have reference to. Firstly, a method of constructing rotary engines of two revolutions, that is, arranged so that the steam having acted upon 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 face plate or plate, 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, 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 one only, 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 curbing the rails of railway axle-trees a coating of iron, the grain of which runs around the axle, whereby 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 seek the favours 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 1846, 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 several plans submitted to the Board of Trade in 1846, a detailed plan together with an estimate (amounting to 121,538l. 18s.) 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 800 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 1846, I proposed a circular cone of rubble 610 feet diameter, and a platform also 10 feet above high water, of the diameter 60 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 decay 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.

94, George-street, Edinburgh,
Jan. 7th, 1854.

THOMAS STEVENSON.

Remarks relating to Proposed Light on the Goodwin Sands; from Chap. III. of an unpublished Treatise on Harbours, by Thomas Stevenson, F.R.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 effort has been shown to, and the carried into, a practical, as the light for the Goodwin Sands. Of the propriety or improwornestiy 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 very much more conspicuous than practical judgment. Our readers are no doubt familiar with the distressing 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, 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, this object,—if it were one,—could be accomplished by merely repeating that exceedingly simple operation which mainly consists in the throwing of stones into the sea, and allow-
ON THE WARMING OF CHURCHES.

By J. H. Boue.

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, which are so much improved, without 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 increase of damp or cold, from attending the services of our Church, it cannot be a useless curiosity to ascertain the 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 church. 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 sometimes be difficult to analyse the names they bear. There are the Phoenix, Vesta, Pyropeumatic, and Patent Chinese stoves, there are stoves with descending flues; Joyce's stove without any flue; and the patent calorific 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 disadvantages 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 stones or under the galleries; they are thrust equally through the bare walls or richly-terraced 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 these stoves in common use. The first is specially 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 warm 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 for every one that 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 Aas and Wenford, since I am informed that it has answered its purpose, and because it is different in its construction from the usual iron stove. A wall is sunk in the floor, 10 feet long, 2 ft. 6 in. wide, and 3 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 escapes. 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 was obtained to keep the building warm. This method 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 church; 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 Phoenix 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 wall. Cold air is admitted in a similar manner, and both can be regulated according to circumstances.

By the kindness of J. W. Huggal, Esq., architect, of Chelsea, I am favoured with a description of a gas stove, which has lately been constructed with great success. It consists of an iron ware chamber, within which the gas burners are placed. Around this there is a space of the same measurement; 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 of the heating 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, is well known, but has 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, and how they 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-
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, the current of air being led down the flue. The smoke enters the furnace, 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 foot, which are thus kept comfortable warm. It will be seen that the smoke from the lemonade does not, like that from a chimney, go across the room, and the greater 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. 8 in., 1 foot in diameter at the bottom, and 8 inches at the top, lined with fire bricks, and having a slit 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 the vestry, or other 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 upward by the air drawn along it from the hole in the floor, 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 30l.; at Weldon, to 65l. 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 the tiles, as frequently as the necessity of the case demands. If 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.

At the Session many 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 Facsimiles of the Chronicle of the Scottish Cluniac and Fish Provinces;' Mr. 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.
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 grating, when the bolt becomes amenable to the key, and the lock opens. In fig. 3 the stump is shown shut up in the levers; and in fig. 3 in the act of passing through the grating. 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.

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 the lock, and fits on the edges of the 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 keyholes, so that the false key that can get in cannot work, and the key that can work cannot get in.

**Fig. 7.**

**Fig. 8.**

**Fig. 9.**

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 "at a glance," without the necessity of removing any of the ordinary keys. The master key is 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 jams of the door.

**ARTIFICIAL STONE.**

**J. STEELE, Inventor, 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 materials, when cool, are again reduced to an impalpable powder, and placed in freely-drawn moulds, to be subjected 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 bevel 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. 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 lever may be dispensed with, the sashes being clasped together by the inclined faces C, and D.

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.

In building a mast or spar on this principle, the core or main centre is made of mallable 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 mallable iron hoops or rings, a light and strong structure is produced at a moderate cost.

Fig. 1. is the annexed engraving 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 piece 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.

Fig. 1. Fig. 2.

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 rotorium, 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.
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.

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 29, 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 actuated 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 economizing 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 plunger-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, 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 e, e, and f, f, seen in dotted lines in fig. 1. The passages b, b, are connected with the steam-chest G, by means of the ports c, c, 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 cylinder D, is connected by four radial arms a, a, 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 the ends of the inner cylinder D. The arms a, a, have radial slots i, i, to receive the sliders or wings N, N, N, N; corresponding slots are made in the heads M, M, O, O, and other heads, secured by bolts e, e, to the heads M, M, having flanges F, F, Q, Q, are metal packing-rings, which are pressed tightly against the ends of the outer cylinder by means of set screws, and form a steam-tight joint. H, R, are the cylinder abutments; s, s, 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 small pistons, working in radial cylinders U, U, and connected with the sliders or wings by the rods i, i, 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, N, N. The valve s is then opened, and the passage or pipe a, filled with steam, which enters the cylinder C, through the openings c, c, and d, d, and acting on the wings N, N', causes the inner cylinder D, to rotate in the direction of the arrow. The spaces between the slider N, N', 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 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, abraded, chased, impressed, indented, raised, or made otherwise uneven.

IRON SHIPBUILDING.
J. 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 uninterupted 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.

Claims.—The formation of an uninterrupted channel or water-course from end to end of iron vessels, in the manner above described.

GAS AND AIR ENGINES.
FABIAN WREEKE, 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. Archimedes, 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 demonstrated 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.

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 Hiero's jeweller, in deceiving the crown. When Marcellus besieged Syracuse, Archimedes, from the walls of that city, raised immense quantities of earth and stones, hurled great stones into and sunk their ships; and by means of mirrors he so concentrated the rays of the sun as to bum the fleet of the enemy at a distance. So highly was this man esteemed for his mechanical construction, that, when Syracuse was taken, although 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 trife, with which a mathematician 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 power of the principle of the arch, and the introduction of the use of metals. So strange was this first inroad of rudeness upon the 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 impart 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 beginning was made by this false doctrine of philosophy until the close of the 18th 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 dispute, or that they may despise others, or for emolument, or for fame or power, or for their own, but for the purposes of life. "The greatest error of all the rest," he said, "is the misunderstanding of 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, since 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, when contemplation and action may be more nearly and strictly conjoined and united.

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. 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 a account of iron from the ore to the bar; another, to inquire into the manufacture of nails; another into the making of lead; a fourth, delivered a full and elaborate report on the history of the manufacture of cloth, as in use. Trades 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, chemistry, 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 the papers consisted of entertaining subjects which now excite our ridicule when read. 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 8th of June, the Duke of Buckingham was called a member, and presented a pair of unicorn's horns. The Society was requested to experiment with it, and 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."⁴

The instrumental concern 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 lodestone, seem to have comprised their collection. With these, however, they conducted a great variety of experiments. Everything 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. "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 plate-board. The second invention was a form of a new microscope..."

The new institution was not, however, so successful. 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 rats makes in Virginia. The outline of the process was this: "Some little boxes of small rye or barley were bruised, and these were tied in the clout of a long-stick; this was then held to the nose of the rats, 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."⁵

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, has been a year. The shooting whales, 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.

1 Plutarch's Life of Marcellus. ² Plutarch's Life of Archimedes and Marcellus. ³ Bacon's Essays. ⁴ Bacon's "Advancement of Learning," 174. ⁵ The Royal Society was an attempt to reduce to practice Bacon's notion of the New Atlantis. The influence of Bacon was not limited to England—it extended to France, and eventually throughout the Continent. In 1615, Bacon corresponded with the mathematician Huygens, the foremost scientist of the day, by letters in reference to his ideas on the nature of science and the method of investigation and discovery. And Descartes, who was one of the original founders of the Royal Society, dedicated his Discourse de la Méthode to the Duke of Buckingham. He was one of the men who had been associated with Bacon in the papers to Mercurius, in 1642, that he was familiar with, and entertained the most profound respect for the works of Bacon.

New Atlantis. The influence of Bacon was not limited to England—it extended to France, and eventually throughout the Continent. In 1615, Bacon corresponded with the mathematician Huygens, the foremost scientist of the day, by letters in reference to his ideas on the nature of science and the method of investigation and discovery. And Descartes, who was one of the original founders of the Royal Society, dedicated his Discourse de la Méthode to the Duke of Buckingham. He was one of the men who had been associated with Bacon in the papers to Mercurius, in 1642, that he was familiar with, and entertained the most profound respect for the works of Bacon.

Macaulay tells us, that Chief Justice Hale and Lord keeper Guilford stole a portion of Bacon's essay from their judicial robes, and the life of the essays which Charles spent much time in his laboratory at Whitehall. "It was almost necessary to range these ... ... a very fine ... ... microscope actually made a fly look as large as a sparrow." Macaulay, Hist. of England, p. 880. Pepys's Diary, May 10, 1667.

From our present height of science, we can look back and behold these pioneers clearing the plain below, now gradually surmounting the obstacles 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—rest assured, substantial, beneficial to their object, and the omnipotent philosophy of induction for their guiding beacon. At last, in the lapse of time, we behold their Gregory, Davy, Wolaston, Cavendish, Brewer, Daniell, Faraday, and their companions, 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 Mechanic Arts, and the era of the steam-engine. At that time James Watt was fifty-five 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 the nation. 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 is unshaken. The noblest monuments of man's 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 mines, 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 gladens our ears with the hum of a hundred workshops. It has given to the South a world-wide and inestimable market for its staple; it has filled the Vauxhall with vigorous life and abundant wealth, carrying its harvests to the Eastern world, bringing back to us 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 any of our federal Constitutions. To that engine the works of Arkwright, Fulton, Priest, Fitch, and Arkwright, 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 the Fourteenth, founded in 1666 the academy of the sciences of France, and the 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 personal enmity customarily converged. It would further be my duty to show how, in rapid succession, there succeeded 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, reflected back by many states, reared to industrial art. Peeling themes to our own country, and latter days, I should call to mind the origin of 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 and frequent crowded exhibitions, and her able defenders to justify 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'Avaugour, a founder 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, unsoiled 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 committee, originated. The system 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 1848, in the Chapelle 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. These exhibitions, it will be remembered, were all carried on by the government 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, we have 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 which, as we have seen, 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 1815, at Hyde-park, was intrusted to a local committee of that Institute, in June 1845; and, after great exertion, they succeeded, with the aid of Prince Albert and the Royal Commissioners, in completing their work on the ist of May 1851. That exhibition was but a development of our own annual exhibitions; yet, when we regard its extent, magnitude, 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 1646 feet long by 406 feet wide, and 108 feet high, the cost of the structure was about 23,000 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 Finland, in the east, to the city of Tripoli in Africa, and Egypt; from Moselem 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 transport vessels for the transport of the products of the great Bay of St. James. 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-
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 ploughshares, and the battle-axes into the pruning-hooks. When the Royal Commissioners resigned their commission at the inauguration, the chairman announced the object of their work to be to conduct 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 inculcate friendly sentiments and 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 time been combined. 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 she ought to establish 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 sorely 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 these 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; and 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—when the book of political and industrial philosophy, America, was adopted as a model for the new statesmen that people human society. 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 our national 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 the practical arts; that 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. The Institute of Technology, the Central College of Arts and Manufactures, and the École Polytechnique, Paris, in her School of Mines, in her Conservatory of Arts and Manufactures, and in her Industrial Colleges at Angers, 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 be the equal of England.

England, thus speaking of 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 made it a law of the land. It is now a fiscal policy of 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. Were there any effect preserved in the countries of the world, it might influence the 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."

The illustrious Lébigé 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. The 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."

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 invention are the only means on which the future depends. 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 progressive application of their capital to research in 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."12

In this great struggle between the nations of the earth, what possible helps can American mechanics offer to assist those 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—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 and Middle schools are 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-
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 men, of engineers skilled in civil and mechanical, 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 Humphry 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 you are 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. Letter not in the path which these great men have opened, lest you be overpowered 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 constrictions. 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.

2. Reduced time of work, and in comparison with the springs in present use, by which means a saving of several hours in the hours in which the work 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:

Buffer-springs on North-Western Railway, including steel-plates, all iron work used with same, 4 buffer rods, buffer-blocks, plates, buffer-hands 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

Savings 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.

The saving of weight in this case is 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 break the 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 power (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, 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 four 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, D, E, are 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 8 a double-action draw-spring. Fig 1 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 various interesting and practical 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 very useful feature, that the writer proposes to avail himself of many interesting and instructive 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 very useful feature, that the writer proposes to avail himself of many interesting and instructive 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 very useful feature, that the writer proposes to avail himself of many interesting and instructive 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 very useful feature, that the writer proposes to avail himself of many interesting and instructive applications to the industrial arts.
Inside Wagon (partly in Section)
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 Worldly?" and "Popular Fallacies,"—which, independently of their application, and in consideration of the diversity 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 said to be the working within of the mechanical 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 institution where the man of business undertakes 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 minds have established, to show that the harmony of the several parts of the system, as compared with the earth, is in favour of a similar organisation. In developing this from a variety of facts, some interesting examples of analogy 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 the geological conditions; secondly, of botanical; and thirdly, of zoological conditions. Nevertheless, there is a harmony of results from the numerous solutions presented 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 the 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 seems 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 those of vision. By this sense, we receive this perception, subject however to many qualifying conditions of form, magnitude, brightness, and colour. There is not one of these qualities, however, which is not open to many mistakes 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. It is not every person impressed, with a conviction that the apparent magnitude of the sun will rise, 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 when it is at its maximum distance from the earth, when it is at the horizon, and when it is 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 object that 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 with 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 made, the sun can be viewed in the same manner when at or near the meridian, it will be found that the threads will exactly touch its upper and lower limbs, and that their interval will still measure its apparent diameter. It will therefore be evident, that what is seen in the illusion, 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, refutes 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 the visual angle 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 the objects is in a given part of the heavens, the relation of the sky to the object is the same, 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 while 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."

"Connecting 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 those objects is much greater than it is, 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 large as the moon seen in the zenith, we shall infer that the sun is 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 so great, that we can adduce other and 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 unacquainted with these metaphysical inquiries, to satiate 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 certainly appear 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 in which more frequently the vigilant acquire 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 tent within the tent, its light put out, Its flame stilled, its breath at rest, And lingering on in fear and doubt."

"But soon, the prospect dazzling,
In cloudless starlight on the trees,
And finds itself as so clearning
As that light which heaven sheds."—Mec.-

"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 spectres. If we cast a sheet of white paper on the red wafer, and, looking at the wafer through the spectacles 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 understood. By the action of the red light and the blue light, the retina is rendered for the moment insensitive to the operation of a more feeble red light upon it, for the same reason as the ear would be insensitive to the ticking of a clock immediately after being affected by the discharge of artillery. And when 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 are seen in the wafer. And by 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 of it any one of those elements, it will assume the tint produced by the others. Thus, if the red wafer is placed beside the blue wafer, the red wafer will appear to it with a tint composed of yellow and blue. If it is insensitive 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 conspicuous an example of this.

"But we have not above stated, even a healthy and perfect eye will be rendered temporarily insensitive to the impression of particular colours by being exposed for a short time to the strong action of coloured lights. Opticians are produced this way in the making of spectacles.

"When luminous bodies, such as red sunsets, are thrown up into the air, the white appears beside the red, and are generally imagined to be really blue. The effect, however, is a visual illusion, and not the result of colour.

"In the sky, towards sunset, when reddish clouds are arranged with openings between them, the sky at such openings appears green, although it really is blue.

The astronomical observations on the stars 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 indistinguishable, prove to be double when examined with powerful telescopes. The two stars, thus composing the double star, are of different colours, and it is found that when one is red the other is of a bluish 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.

"Outlines as to Numbers.—One of the most curious and most incomprehensible illusions of the senses is the singularly-erogenous 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 illusion is immense.

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, unassembled by the telescope, is not great. Any one can satisfy himself of this by examining any good map of the heavens; 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, when we find the illusory 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 chromatopsiophobia, or Daltonism. Besides Dr. Dalton, we believe the eminent mathematician, John Bird, in his work on Optics, with a colour-blind eye, was in a position to make a fair estimate.

"The 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 of the many companies of the British railway system, the imperfection of vision due to colour-blindness 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. When a gas engineer has too, perhaps, something to learn with regard to the effect of illuminating substances of various colour.

"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 comprehensive treatment. We say comprehensive, notwithstanding it 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 breath 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 33° below zero, wear no coverings round the throat but the beard. It being found that the German and French masons are less subject to phthisis than ours, Professor Alison, of Edinburgh, recommended the masons of his diocese, 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 firestone is extensively worked, the masons are fine-looking muscular fellows, with large beards, and such a disease as phthisia is never heard of. The official medical statistics of our army shows that the cavalry regiments suffer less from phthisia than the infantry. Steel-grinders, millers, cabinet-makers, and 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, and in countless practical examples 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!"
was merely a long-winded or low-soure 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 light of it, by casting it 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 heroises, when they find how 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 discussions bearing 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 "doubt" and "sudden rage," that they deserve to be laid aside on leave 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 criticism, and 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 use of symbols of the pre-Papal unformed medieval 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 Reformers, — forgets, too, that classical literature helped to lay the foundations of superciliations 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 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 assertions, 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.

RECENT AMERICAN PATENTS.
[Reported in the Journal of the Franklin Institute.]


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.

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 amount 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.

Clamps,—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 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 when there is a pressure of gas, the float rises 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.
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 thanks to those 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, with whose patronage he had for many years associated himself, 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 careers, and the happy contact with, and experience of the proceedings of the older practitioners; contrasted 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 co-founder 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 1858, and elected a Member in 1861, 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 maritimes works on the Thames, the Tyne, the Severn, the Clyde, the Avon, &c.—the harbours and docks at Harwich, Dover, Greenway, Gower, Lowestoft, Portland, Holyhead, Plymouth, Leith, Hartlepool, and other places; the works at the Norfolk Estuary, the reconstruction of Bishop's Rock Lighthouse, and other important works 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 of screw propulsion in vessels. The new system of propulsion invented by Rutherford, 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 contradistinction 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 extensive and miscellaneous works 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 sewage of cities and towns, and also to 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 attempted, it was contended to be insufficient unless the matter be extended on a large scale, and applied 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 Drains of the District, South of the Thames." (ante p. 352.) 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 objection to the underground sewer was to be settled by more careful investigation. It might be preferable to construct two parallel sewers, to be used and cleaned by flushing, or otherwise, alternately; or used for feac matter, or for rain water alternately.

As to retaining, it was a matter that would be insufficient, and a securing 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 outlet, was effectively flushed by its own sewage. The main sewer was stated to be horizontal, 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 11 feet per second was sufficient to keep the system clear.

The plan of the two 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, at high water, to a height of seven feet above that level; in 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 away to the works, where they would be accumulated during the past 124 hours, and commencing its exit at the turn of the top of the tide, the matter would never return to within half-mile of the spot whence it started. The capacity of the reservoirs being equal, there would be a constant proportion of sewage to be discharged 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.

Affluence 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 be from 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 supplies for crops 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 rent of agricultural land and of that of the same area covered with buildings would elicit within good time between the water supply to the requirements 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 the good system of intersecting 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 there, the deficiency probably being 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 river was enabled to cleanse itself by the sea water, when the sea was considerably 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 pumping into the river, and the diminution of the velocity would last, and, as a corollary, certius parsivus, 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 in pipes about 255 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. This result 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 received as authoritative.

The Paper read was a "Description of an Improved Indented Plane for conveying Nodis to and from different Levels of a Canal." By J. Leslie, M. Inst. C.E.

After alluding to the successful indented plane, established by the author, at Blackhill, near Glasgow, on the Monkland Canal, and describing the difficulties which it was intended to overcome, and the points essential for the good-working of such lifts, the paper proceeded to topographical, 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 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 inclined lines was down, for a distance from the

* See Journal, Vol. XV. 1855, p. 201, 276.
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 by a plane, a line 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. To the lower or subsidiary carriage, running on a number of rollers; so as to have no friction 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 ratchet, 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 Viertel, as it was 20 feet above the Schebewasser, which was 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 the water which they used, and that in the competition between railways and canals had ended in the partial abandonment of the latter, in spite of all attempts to use steam propulsion and traction.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAW AND PATENT ACT, 1870.

Dated August 13.

1860. J. Gwynee, Essex Wharf, Essex-street, Strand—Improvements in the preparation and application of pasture, blacking, and various other purposes.

Dated August 99.

1864. J. H. Johnson, Lincoln's-inn-fields—Improvements in the preparation and application of pastures, blacking, and various other purposes.

A communication from F. Durand, Toulouse, France.

Dated October 56.

1864. E. Rider, Cumnor-street—Improvements in the manufacture or treatment of gutta-percha; being improvements upon the invention secured to him by letters patent dated 3rd October, 1864. (Partly a caution patent.)

Dated November 9.

1864. B. J. Richardson, Blackfriars—Improvements in Marylebone—Improvements in power-looms for weaving.

Dated November 7.


Dated November 21.

2701. A. Pickford, Newton, Berkshire—Improvements in the construction of certain descriptions of vehicles.

Dated November 29.

2712. R. Adams, King William-street—Improvements in fire-arms.

Dated November 28.

2741. A. V. S. de Montfort, Paris—Improvements in wheels for vehicles on common roads and railways.

Dated November 99.

2771. J. C. Ramsden, Bradford, Yorkshire—Improvements in apparatus or the mechanism of looms for weaving certain classes of plaids, checkers, and fancy woven fabrics.

Dated November 99.

2772. E. J. Hughes, Manchester—An improved method of purifying and concentrating the coloring matter of madder, madder, and any preparations thereof, however they may be made.

Dated December 1.

2783. T. Crick, Lawmore, near Clitheroe, and D. Adamson, Deniscopal—Improvements in generating steam and in consuming smoke.


Dated November 99.


Dated November 29.

2787. T. Hollinsworth and J. Hollinsworth, Walsall, near Warrington—Improvements applicable to steam-wharves, to be used upon railways, or as signals where otherwise required.

Dated December 1.

2788. J. H. Johnson, Lincoln's-inn-fields—Improvements in the treatment or machinery for communicating.

2789. J. H. Johnson, Lincoln's-inn-fields—Certain applications of vulcanised india-rubber. (A communication.)

Dated December 2.

2790. J. Reilly, Manchester—Improvements in machinery or apparatus for toning or heat-treating metal, or other substances.

2801. A. W. Gillen, Pickwich—Improved excavating and dredging machines. (A communication.)
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 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, 80 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-pinned pilasters, surmounted by an enriched bold castellated 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.

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 contouring.

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 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 develop 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, what is worse, a wise are directing the expanding thoughts, the raising genius of the age, to 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-leveling, 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 the surface. Suppose this model to be placed in a water-tight box, with a line drawn along 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 35 feet), and draw a line across 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 from the actual distances on the ground; the farther 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, the 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 determine 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.

No. 240.—Vol. XVII.—March, 1854.
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'Neil, who is an uncompromising advocate of the Ordinance six-inch map, and of contouring, states, in answer to Question 74, 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. Gosses was applied to in this dilemma, who does not much mend the matter; for, in answer to Question 60, he states, that "When the survey was in its infancy, the subject had not received the same experience which has since dictated uniformity throughout." The 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 we proceeded; 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 plotted 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, is at the expense of accuracy, 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. They 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-leveling 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 be laid out and chained, to fix the several points where the contour lines cross the lines of the triangulation. 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, is found from the original starting point 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 185, 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-leveling 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 points 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, 185, 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 100 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 levell points may be plotted on the plan, and pickets are driven into the ground at 115, 140, and 185 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 plotted 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 P, and send the height which he makes the point O above the point P, 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 moun-
tain 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 desmesnes and pleasure grounds with high walls and other various obstructions is impossible, and to attempt contouring in a town where the levels can only be placed upon the streets and the intermediate portions sketched, is a purely absurdity and calculated to mislead.

To attempt to get at the exact cost of contouring as executed by the highest hand in the market, is impossible, as the amount 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 1000 foot contour line, where the number of contours rapidly decreases, this sheet, as a whole, may be considered to give a minimum quantity of water-level contours. This sheet contains about 12 lineal miles of instrumental and 644 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 132. 10s. per square mile, and that upon a large average of country.

Any one acquainted with the process of contour levelling, as above described, must admit that 10s. per lineal mile is a very low estimate, and we are therefore driven to the conclusion, that either the amount of 12 square miles must be greatly increased, or the quantity of contouring must be limited to 8 lineal miles per square mile. This is a matter of concern to the district of 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 develop the features or physical condition 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 rates, the mother 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 161, Yorkshire, it will be observed that the instrumental lines show numerous sharp salient points, giving a rugged appearance to the ground, which is not the case with the above sheet; but 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 itself is self-evident. 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 be done in 1 square mile of area, whereas the amount of levelling is 27 lineal miles per square mile; and as contouring must first be levelled and then surveyed, the actual amount of work would be 84 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£, a square mile of detailed survey can be executed for £ per square mile, being about 8ths 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 Ksar inscribes seven ablations of the body, the products of which, whether of 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 outskirts of the Balkan (Hemus) 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 chestnut on the side towards Constantinople, and on the side of the valley in situations of pure water. The slopes of 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 magnificent springs.

The lateral mountains chains, on which Constantinople is built, divide the western valley of fresh water from the Sea of Mar- mora, 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 Deshebathed-i-Koi, which uniues itself with that of Alibbeg-Koi about 14 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 Taksem of Egri-Kapa, a point quite on the point required for the flow of the water,—a point by which the waters of Belgrad and Aiwab-Bendi could be conducted, and whence it could be brought to the Taksem of Egri-Kapa. 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 Alibbeg-Koi valley. The valley of Pyrgos was crossed by means of an aqueduct called the long one, extending to 3000 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-Deremi has also its reservoir and aqueduct. Two other aqueducts take up the waters of the Belgrad and Aiwab-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 Alibbeg-Koi valley, where they are carried over the Aqueduct of Justinian. The latter is a superior work of hydraulic architecture, and undoubtedly the finest left us from the middle ages.

The Taksem at Banari is connected with the Aqueduct of Valens; it lies 53 feet below the upper part of the latter, con- sequently those two works belong to two quite different systems. Most writers, amongst whom is Gylla, who has been continually copied, assert that the Aqueduct of Valens receives the water coming from Belgrad, which is erroneous.

The Taksem of Sta. Sophia furnishes the seraglio of the Sultan with water. After the stream has passed underneath the Bosphorus, it slopes down the valley of the Harem, whence it is raised by what is here called a "Norin," and then discharges itself at Tap-Kapruzzi in a basin, which is said to be 170 feet long and 100 feet broad, and on which piles 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 the Crooked (Bosporus) are situate near the banks of the Pyrgos. Their plan forms an equilateral triangle, of which that from the Long Aqueduct to that of Justinian forms the base, upwards of 43 miles long, while the other two sides, which unite the Crooked Aqueduct, have each a length of nearly two miles.

The Crooked Aqueduct is distinguished by the fact that its water 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 700 feet long. The place where the branch consists of the two slopes is marked, the water widening and enlarge towards the top, obviously impeding 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 arches 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 bridge-like shape of this part of the aqueduct 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 dispensable with.

The Long Aqueduct is, perhaps, of a more imposing character, as it is far more elegant in 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 237 feet, and height 84 feet.

Reservoirs or basins are called at Constantinople Bash-Hawus, 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 flowed 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 Kysaris of the ancients, and consists of two tiers of large pointed arches, those of the lower being 168 metres in the clear; those of the upper tier have a span of 1511 metres. These arches are supported by pillars standing on flat supports, of round or square height 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 13 metre 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 83388 metres, its height 3868 metres, and the pillars at their base are 1656 metres thick. The width is 965 metres, and its pillars are 1560 metres 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 and the most remarkable works left by the Greek emperors. Although this 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 7 years.

The Aqueduct of Valens (Aqueductus Valentinianus) transmits 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 arches, the upper, however, being removed for the sake of obtaining a better view of the

* Abridged from the "Androgynus."
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 movable 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 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 1st of January, included six Fresco paintings, 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, consisting of six statues, in Berlin, a saving may be effected on the estimate. It is said that such surplus may be conveyed 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 estimate.

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 window was to be submitted to the place, and as affecting the light, was left to the architect.

Fresco Paintings.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Artist</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Religion</td>
<td>J. C. Horsley</td>
<td></td>
</tr>
<tr>
<td>Justice</td>
<td>Daniel Maciels, R.A.</td>
<td></td>
</tr>
<tr>
<td>The Spirit of Chivalry</td>
<td>Daniel Maciels, R.A.</td>
<td></td>
</tr>
<tr>
<td>The Baptism of Ethelbert</td>
<td>Wm. Dyce, A.R.A.</td>
<td></td>
</tr>
<tr>
<td>Prince Regent</td>
<td>Harry V., acknowledging Authority</td>
<td></td>
</tr>
<tr>
<td>C. W. Cope, R.A.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edward the Black Prince receiving the Order of the Garter from King Edward III.</td>
<td>C. W. Cope, R.A.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remains: Of the six statues above named, commissioned to furnish designs for those 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.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal Statues of Eighteen Barons and Prelates who co-operated in obtaining Magna Charta.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Artist</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Stephen Langton</td>
<td>J. Thomas, Modeller</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Henri de Londres</td>
<td>J. E. Thomas, Modeller</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Almerio, Master of Knights Templars</td>
<td>P. M'Dowell, Modeller</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>William, Earl of Salisbury</td>
<td>J. Thomas, Modeller</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>William, Earl of Pembroke</td>
<td>P. M'Dowell, Modeller</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>William, Earl of Warwy, Earl of Warren</td>
<td>J. Thomas, Modeller</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>William, Earl of Arundel</td>
<td>W. Woodington, Mo. Moore, Co., Casters</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Robert de Burg, Earl of Kent</td>
<td>W. Woodington, Mo. Moore &amp; Co., Casters</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Richard, Earl of Clare</td>
<td>J. S. Westmacott, Modeller</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>William, Earl of Anmerle</td>
<td>J. S. Westmacott, Modeller</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Geoffrey, Earl of Gloucester</td>
<td>J. S. Westmacott, Modeller</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Saber, Earl of Winchester</td>
<td>J. S. Westmacott, Modeller</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Henry, Earl of Hereford</td>
<td>J. Thomas, Modeller</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Roger, Earl of Norton</td>
<td>J. Thomas, Modeller</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Robert, Earl of Oxford</td>
<td>F. Thrupp, Modeller</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Robert Fitzwater</td>
<td>F. Thrupp, Modeller</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Eustace de Vesci</td>
<td>A. Hitchie, Modeller</td>
<td></td>
</tr>
</tbody>
</table>

UPPER WAITING HALL.—The decorations are as yet 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 illusion of the work was lost for some time, until it 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 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.

**Subjects.**

Chaucer: "Griselda's First Trial of Fiate.

Spencer: "St. George overcoming the Dragon.

Shakespeare: " Lear's Disinherited Cordelia.

Milton: " Satan touched by Sorrow.

Dryden: " St. Cecilia.

Popes: " Personification of Thanes.

Scott: "Death of Marmion.

Byron: "Death of Lara."

**Frescoes.**

**Artists.**

C. W. Cope, R.A.

G. F. Watts.

J. R. Herbert, R.A.

J. C. Hosley.

J. Tenniel.

E. Armitage.

E. Armitage.

C. W. Cope, R.A.

**Dates and Estimate.**

The fresco of "Griselda" and that in illustration of Pope were completed respectively in October and November 1848.

The fresco in illustration of Pope was completed November 1842.

Those in illustration of Scott and Byron were not completed when this Report was written in 1853.

The cost of each painting was estimated at £500, £200 for the cartoon, and £200 for the fresco. The amount would therefore be £200. But one artist, after having completed his cartoon, for which he received 200l., 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 100l. was, under the circumstances, accepted by the artist.

The sum of 100l. was therefore added to the original estimate, making £600.

**Stucco.**

**Artists.**

J. H. Foley, A.R.A.

J. H. Foley, A.R.A.

John Bell.

W. C. Marshall, R.A.

W. C. Marshall, R.A.

John Bell.

F. M'Dowell, R.A.

E. H. Bailey, R.A.

**Dates and Estimate.**

The statues of Lord Clarendon and Lord Falkland were completed in January 1848; that of Hampden in October 1845.

The other five statues, for which compensation had been given, are not yet completed.

The first three statues were estimated at 1200l. each, making 3600l. The estimate is now reduced to 1000l. per statue; the cost of the eight statues will therefore be 8000l. The cost of the twelfth will be 12,800l.

**Marble Statues.**

**Artists.**

J. H. Foley, A.R.A.

J. H. Foley, A.R.A.

John Bell.

W. C. Marshall, R.A.

W. C. Marshall, R.A.

John Bell.

F. M'Dowell, R.A.

E. H. Bailey, R.A.

**Dates and Estimate.**

The Legend of King Arthur, The agreement dates from July 1848. The work is in progress.

The agreement provides that the artist shall receive a salary of 800l. a year for six years, making 4800l.

The amount above 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 house, 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 Judgement, 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.

In the single compartment, on the West side:
1. Moses bringing down the Tables of the Law to the Israelites.
2. The Fall of Man.
3. His Condemnation to Labour.
5. The Visit of the Queen of Sheba.
6. The Building of the Temple.

In the two smaller:
10. Charles II. assisted in his Escape by Mrs. Lane.
11. The Executioners tying the Neck of Montrose.
13. The Landing of Charles II.

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 2500l.; 500l. for the first picture, and 450l. for each of the remainder. Edward M. Ward, R.A., is the Artist.

Oil Paintings.

1. Charles II. assisted in his Escape by Mrs. Lane. Opposite
2. The Executioners tying the Neck of Montrose. Opposite
4. The Sleep of Argyll. Opposite
5. The Acquittal of the Seven Bishops.
6. The Lords and Commons presenting the Crown to William and Mary, in the House of Commons.

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 frescos for the Upper Waiting Hall, and in the case of the bas-reliefs for the Prince's Chamber, that works can be varied when circumstances alter. Such an arrangement has been only recently proposed; it appears for the first time in the Estimates for the year ending 31st March 1858, that it is only now 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 100l. The Commissioners had already set apart the sum of 120l. 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 50l. 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 170l.

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 already been 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. This artist, in any case, is not connected with the Commission; he is paid a salary, except the secretary, who had the honour to be appointed by her Majesty. The secretary at present receives 70l. 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 site 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. It is intended that the building should be converted, after its temporary use, into winter, or rather botanical conservatories, the construction has been based on the same. The area of the Industrial Hall is calculated at 150,000 square feet. The plan has been designed by M. Voit, the architect of the New Pinakothek. The chief entrance will be from the street, which separates the North entrance of the transept. The building is to be completed in June next, consuming thirty days for the erection of the ironwork, and the glazing of the glass roofs. It is 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. The private dock is surrounded on three sides by eight stacks of substantial warehouses, each stack being provided with a staircase and enclosed 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 1,238,927 cubic feet, and 116,200 feet superficial area. The ground story or quay is paved with Pennant stone, grouted and beeded on river shingle, filled-in on a bed of concrete. The walls stand on a mass of concrete, in some places upwards of 18 feet deep. They are built in rubble-work, with excellent sandstone from the local quarries, the facing being random-range work, with ashlars angles, reveals, piers, and arches, all hammer-dressed. A moulded string runs round the top of the arcade, and divides the ashlarn 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 Aberdare 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. Hadley 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 90 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 sky-light 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 80,000 square feet. The rain-water columns, 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 antefaces.

Mr. James Haywood, of Derby, is the contractor, and Mr. Wm. Fairbairn has been appointed by the Committee 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, the centric 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, but it works with the fixed eccentric. At a high pressure the 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 1861, since which great improvements have been made by them.
Scale \( \frac{1}{2} \) = Foot.
SMITHFIELD MARKET, MANCHESTER.
Details 1 inch to a foot

Elevation of Upper End of Queen Bolt and Strut together with Louvre Standard & Section of Louvre Frame.

Section of Sash Bar with Wood Roll 1/8 full size.

Elevation of Middle Standard for supporting Skylights.

Elevation of Ridge Standard & King Head with Section of Ridge and showing part of Glazing Bars.

Elevation of King Bolt and Struts and part of Tie Rods & Connecting Links.

Elevation of top of Column and foot of Principal with Section of Gutter.

Section of Rafter 1/8 full size.
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 sections which have expired. 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 new 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 shall not have been authorized by a former act is proposed to be made. The second class includes all those bills for which no 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 the original bill is introduced, with the plan 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 where the powers of the original act have expired, as then the new bill can scarcely be called a bill for continuing or amending 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 second class bill must be brought, 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 former, even when any powers have expired, this will be still more strongly opposed to allow the bill to rank of the first class when the 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 vary much although 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 Lords, that nothing can 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 the 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 of which the action of sails and rudders depend. After the most rigorous examination of this point, as 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 be the angle that should 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 will require the stern 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 pointed out the different facts for keeping the ship on course, 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 by the initials of Fox and Barrett's materials, and stated that the objects accomplished by this system, whether applied to public buildings, dwellings, houses, 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, asphalt, tile, slate, stone, or other material; or upon which foundation the ordinary boarded surfaces, with light sleepers or bevelled fills, 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 englobes the strips in mortar. A layer of concrete is then applied, of the thickness of 1 1/2 inches, probably 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. The 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 girders together with the ironwork together. It is, however, more satisfactory to prove the joists, and it is done with a lever at the most tried 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 fixed, and the prongs of a triangular form may 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.

At the finished surface of the joists lies the cover-boards, cement of different kinds, such as Portland, Kansas, and Parian, may be used. Ashphalt, metallic lave, slates, and tiles in cement have also been employed as a finished surface, both for floors and roofs.

In applying this system to dwellings, houses and similar buildings, the joists are first tested singly to bear weights equal to from 1300 lb. to 1500 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 material. For building in a different case, on 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 put upon they form a series of ties, which greatly strengthen the building. A considerable accession of strength is given to the joists, and is fixed in the following manner: Every successive step in the process of construction tends both to develop 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 to the original strength of the joists is, cannot easily be fixed, 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 190 lb. to 150 lb. per foot, the average ultimate strength is 406 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 may be increased to 1448 lb. per feet square upwards of 73 tons. If 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 dwelling-house, which if packed with 300 people, or as full as the "Black Hole" at Calcutta, would only be loaded up to 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 joints 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. There is also fixed round and the joists to the ends of the supports. When however, the span much exceeds 30 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 30 feet apart. Floors of 150 feet span have 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. Additional drawings have been enabled to be published in the various systems referred to by Mr. Barrett, in our report of the discussion next month.
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL.

while there is probably no kind of building to which it is not capable of being adapted. Beside 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 poor, and the system 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 because I desire to make it clear that while it originated in having invented 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, and I may say to everyone's, the late Mr. James B. B. C. T. in 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 misunderstand the importance of the work may 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 its patentee, while, as I gather from Mr. Burnnell'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, one only of whom referred to the use of iron through which a building of this kind has been erected, 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 plaster, which made such an appearance as this double arrangement of wrought-iron columns. The double columns are shown in plan at the top of the pot to receive timber-joists, upon which the floorboards were laid. The whole appeared to be a very expensive mode of construction, occupying a depth of about 18 inches for a span of 15 metres, 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, and the result is a form of interlaced of wrought-iron 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 interlaced wrought-iron girders are necessarily much more expensive than the structural wrought-iron girders, they are placed much closer together 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 result of the two modes of construction are different,—the one requiring a large amount of iron, the other a small amount, and 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 buildings, where the use of girders is necessary, the drawing (See Nos. 10 and 11) exhibits two of the buildings of the last two years, one 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. 9, an Ironmongery Warehouse at Brighton, in St. Mark's Court, Chelsea, the Metropolitan Cor- valescent 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 in these cases adapted to the thickness of the floor, while 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 rusticated beam, as shown in the figure, or the lower face of 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 30 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 girder and cast-iron joists, as adopted at the recently erected extensive addition to Guy's Hospital, which is a room 7 feet square by 50 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 the girders and joists are of wrought-iron plates. The plates 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, Har Majesty's New Highland Residence, Salomons, &c.), 42 feet being the width. It is a combination of wrought-iron columns, 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 impart or vibration. In cases, however, where the use of columns can be admitted to shorten the beams 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 Nos. 10 and 11 show the application of the principle of the building shown in drawing No. 9 being the plan of a floor 63 × 38 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 extra support 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 piece, or they may be bolted to a plate of iron built into the wall. The extreme ends of the girders being placed so as to be secured 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 length, and the one subject to the other, which is not the case in drawings Nos. 10 and 11. The joists are 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 successfully adopted in buildings of every description, but have been before and for many years past 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 same— but for the manufacture of which no rolls were in existence. Experiments were therefore tried on I shaped bars, and a formula deduced from these, and acted upon by having my rolls prepared from 4 to 6 inches deep of the same section. Subsequent experiments showed that I had verified the formula, but 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 0.5 per cent. I had heard that iron joints were coming into use in France, but knew nothing of the strength they employed, and have never seen either the joints 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 joints, and a printed statement of experiments on their strength. This information and the experiments are important as bearing on the question of cost, to which I will almost immediately refer. It seems that under circumstances, and except in a very extraordinary case, would they place the joints less than from 70 to 80 centimeters apart; and for a floor of 6 meters, joints 12 centimeters deep, and weighing 14 or 15 kilogrammes per metre, would be used.

I think the first point to establish is the sufficiency, or rather the actual strength, of the joints, of the scantlings used in Paris, and the table of experiments enables us to examine this:

Joints of 12 centimetres deep, and weighing 15 kilogrammes per metre, were tested at between 14, 6, 8, and 10 metres. Converting these into English dimensions, we have for the bearing of 6 metres, 19 ft. 81 in.; for the depth of the joint, 4½ inches; for the weight per foot run, 10 lb.; and for the mean distance apart, 75 centimeters, or 30 inches. From the table I find that a joint of these dimensions was proved at 6 metres bearing with 5000 kilogrammes on centre, which is equal to 4000 distributed, or 8500 lb. English. The area of floor this joint would carry is:

\[19'8" \times 2'6" = 49'2" \times 8900 lb. = 49'2" = 178 lb. per foot.\]

But a similar joint was proved with the same weight at 8 metres bearing, which is equal to 5533 kilogrammes at 6 metres:

\[5533 \text{ kilo.} = 11730 \text{ lb. English.} = 49'2" = 210 lb. per foot.\]

But even this did not reach its limit of ultimate strength, for the joint was further tested at 10 metres 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 joint.

None of the joints I use have been tested to anything like this extent, 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 joint 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 square of the size, and I will reduce both this and all the others 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 joint—a weight of 10 lb. per foot gives a sectional area of just 3 square inches; and a rectangular bar of this area and 4½ inches deep, would give the following result:

\[15 \text{ kilo. per metre} = 15 \text{ lb. per ft.} = 3 \text{ sq. in.} = 4'75'8" \times 68 = 14'214\]

while the English joint—16 lb. = 4'8' = 7'4' \times 880 = 33'014

And further,—

\[14'214 = 19'5" \times 30" = 285 \text{ square foot, and 33'014} = 20'0" \times 24" = 340.\]

Giving the result of a comparison of strength just 1 to 3; while a comparison of weight would stand thus:

\[15 \text{ kilo. per metre} = 450 \text{ lb. per sq. in. English joint carries 20'0" \times 24" = 490" = 3621.8" \times 3700 lb.}\]

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 joint is equal to 300 lb. per square foot, it is in my case equal to 300 lb. per square foot; but even this is assuming that no strength whatever is in the principle of construction, which 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:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost of fireproof floor</th>
<th>Cost of fireproof floor with boarded surface</th>
<th>Cost of timber floor</th>
<th>Cost of timber floor, pugged</th>
</tr>
</thead>
<tbody>
<tr>
<td>Five rolled joints, 12' 8&quot; long, 84 lb. per foot—</td>
<td>$67.0</td>
<td>$67.0</td>
<td>$1.80</td>
<td>$1.80</td>
</tr>
<tr>
<td>Concrete, 6&quot;, ceiling and cement surface of floor, 56 sq. per</td>
<td>$1.80</td>
<td>$1.80</td>
<td>$1.80</td>
<td>$1.80</td>
</tr>
<tr>
<td>Timber Floor—</td>
<td>$11.70</td>
<td>$11.70</td>
<td>$1.80</td>
<td>$1.80</td>
</tr>
<tr>
<td>11 joints, 18' 6&quot; long, 9&quot; x 2&quot;=114 cubic feet @ $3.</td>
<td>$10.60</td>
<td>$10.60</td>
<td>$1.80</td>
<td>$1.80</td>
</tr>
<tr>
<td>Wall plate, 40 feet run, 14&quot; x 8&quot;, @ $1.50</td>
<td>$4.60</td>
<td>$4.60</td>
<td>$1.80</td>
<td>$1.80</td>
</tr>
<tr>
<td>Herring-bone strutting, 48&quot;, per square</td>
<td>$0.60</td>
<td>$0.60</td>
<td>$1.80</td>
<td>$1.80</td>
</tr>
<tr>
<td>Half-brick trimmer and centering, 6&quot; x 2&quot; @ 6c.</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$1.80</td>
<td>$1.80</td>
</tr>
<tr>
<td>144 feet, 1 inch flooring boards @ 34c. per square</td>
<td>$3.10</td>
<td>$3.10</td>
<td>$1.80</td>
<td>$1.80</td>
</tr>
<tr>
<td>16 yards lath and plaster ceiling @ 1.6d.</td>
<td>$1.14</td>
<td>$1.14</td>
<td>$1.80</td>
<td>$1.80</td>
</tr>
<tr>
<td>144 feet, 8&quot;, floor joists @ 34c. per square</td>
<td>$1.80</td>
<td>$1.80</td>
<td>$1.80</td>
<td>$1.80</td>
</tr>
<tr>
<td>Cost of timber floor, pugged</td>
<td>$28.16</td>
<td>$28.16</td>
<td>$1.80</td>
<td>$1.80</td>
</tr>
</tbody>
</table>

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 joints 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 French 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 saying 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. The question of Mr. R. S. Mirrlees was that the space between the joists might be filled in with any fireproof material. The joist adopted by him was of this form 1, 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 house, where he had been employed; as a matter of fact, several fires had occurred, 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 surface, the iron being filled with Roman cement, and the lower rented 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 be useful for a range of offices in a 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 the purposes of the building. 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 position of the new stove to the fire, the fixing of iron consoles, 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 girders with the flange upwards, 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. It was very glad the subject had come up, and wished it would be of some 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 preciosity, 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 Willthurst 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 a floor more than 73½ 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 manner that degree of rigidity, the building referred to had incorporated 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 used and the whole system would have an entirely new and a better lease of life. He had seen the danger of any doubt was, as to the action of any damp which might arise from the concrete, supposing the wooden floor to be laid covering it
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL

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 he was convinced they were not a feasible 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 1½ inch to 1½ inch thick, screwed to the underside of the wooden joist, were held to the violent blast of a true barrel-torpedo, and even 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. PANNON 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. Titre, they yet showed the great advancement those two systems. The concrete and other substances were superior to York landing, insomuch 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 the floor became perfectly rigid. He had employed Mr. Barrett's system in a large dwellinghouse 45 feet by 28 feet in dimensions, and the cost of iron did not exceed 90d.; the whole of the timber being saved.

Mr. Titre explained that the York stone in Mr. Barrett'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 fear, and 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. Titre, and whether in Mr. Barrett's experience, he had ever found the concrete shaken off from the joists.

Mr. Barrett stated 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 what he called the impossibility of the concrete being taken for granted. After an experience of twenty years with bearings of 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. Boulnois had not been able to prove his possibility with referring to his own experience, confirmed as that had been by Mr. Boulnois himself.

Mr. Titre called attention to the question of Mr. Boulnois as to the degree of strength and rigidity of the concrete taken alone; and an 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 it, giving the thickness, and to be destructible by fire, and that practically it did not furnish a fire-proof 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. Titre inquired what experience there had been of the action of fire on concrete. He apprehended if there were five 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 warehouse, 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 not agree that the metal was affecting the fire at Messrs. Collard's manufactory at Camden-town.

Mr. Piper said that 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 proprietors 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 referee, 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 force was not quite so direct and 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. Titre 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. Scouler observed, that if the ceilings were plastered where these fires occurred, the concrete had not been tested.

Mr. Herkth 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 when the patent was used. If the patentees proved it to be fireproof, this object might be attained.

Mr. Boulnois said it must be content with referring to his own experience, confirmed as that had been by Mr. Boulnois himself.

Mr. Titre having referred to covenants to leaseholdholds to two-thirds the value, it was said he had advised the Wills' Trustees 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 7s. 6d. to 1s. 6d. per cent.

Mr. C. H. Barron referred to the causes which rendered some of the cases of lapse of laths unconnected with 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, and in the Portland, York or other vitrified clays, and toPortland cement (1-3 inches thick), were placed further apart from each other than from 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, forming two, or three times the thickness of the English system. Nor was there, under discussion, could be considered perfectly novel; and indeed, so far back as the year 1840, 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 box-shaped plate 1/4-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 being filled in by arched brickwork.

With reference to the question which had been raised, 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 settling, expands less in the English system. As to the question whether the construction of Mr. Delaunay had forwarded the information 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 sulpharic 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 sulpharic 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 constructing buildings and adding to the expansion of the French system. The stone of this country is a subdivision 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, and in the English system it is not reduced to powder, but is 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 kind of stone, they construct of it 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 faccitions crystalisation, 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 cohesion and augmentation of volume will insure solid and durable work.

In February 1849, Mr. Charles Barry read a paper describing a system of construction proposed by Mr. Beardmore, in which the reliance was placed upon concrete, formed of Portland cement and ashille, 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, 18 inches deep, 1-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, 3/8-inch 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, acting on the two sides of each plate, and the 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 girders. For a span of 15 to 18 feet the depth of floor would be 3/4 inches; from 16 to 20 feet, 1 inches. Mr. Beardmore considered his floors to be fireproof from their mode of construction; not liable to disintegration when exposed to fire, flame, as brick arc are by their falling off in flakes, nor to be destroyed by sudden cooling when highly heated. The thickness of the floor, when contrasted with one of cast-iron, and the absence of all lateral pressure, and consequent necessity for tie-bolts, were another advantage; in addition 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. Burke, 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 Tuileries and Louvre. As to the question which had been raised, the composition of girders and joists of the same form. The joists are so proportioned that the deflection of the floor under a load of 700 kilog. per superficial metre, or 143 lb. per square foot, shall not exceed 20 centimetres (or 1 3/8 inch), which may be thus explained: We suppose that four persons might stand in the space of a superficial metre (or 104 square feet), and that their joint weights might equal 800 kilog. or 661 lb.; we add as the weight of the interties, fastons, pottery, small wooden joists, 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, though for the purpose of ornamentation and dissection 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 master-builder of the employment of these methods for modern spans. 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 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 Hutton.

"I have been told, 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—four men is 300 kilog. (651 lb.) per superficial metre (661 lb. per foot superficial). When these limits are surpassed, which is the case in most 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 difference in the flooring, render the production of large joints very doubtful, as regards the equality of texture, and in many instances those of from 22 feet to 24 feet long, and from 8 1/2 inches to 10 inches deep, have broken on being proved; but nothing is to be feared from the employment of these methods for moderate spans. He 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 cannot be prevented, when the plaster is a sufficient thickness (say
4-inch) to exclude the air. This fact is sufficiently proved by the frag-
ments 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. Decroix

"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 4-th of the span. The filling
in between the joists is generally of pottery or hollow bricks, bedded in plaster
or cement. The plaster is not too thin, being only one thickness of the plasterer's
empty spaces properly filled-in, the necessary rigidity is obtained. We avoid the
use of concrete on account of its 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 sun can be dispayed by
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 humid air; but according to the thickness of the plaster, and after a
latter period, the plaster in its turn protects the iron from the atmospheric
influences. It must be acknowledged, that experience as yet can say
little on the matter. In twenty, thirty, or a hundred years, we shall be
better able to say something of the system, but the present manufactory
is 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,
they 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 Bourdaisois and the Rue de Desgacheurs; we do not yet know the
numbers."

Mr. Burnell continued—From these communications we may
briefly sum up the following facts:—That the plancher-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 plancher-en-fer, placed 2 ft. 7½ in. apart and properly
filled in, will produce a floor, whose breaking weight is not
exceed 4-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 1 ounce, consisting of a thickness
of breaking weight of the joist, or that the depth of the joist should
not be less than 4-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 observed before, the object in dwelling-houses is to avoid the
twist in question 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 light-
ness, 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 two advantages on the score of dura-
bility and convenient execution, for it no more requires for
workman to adjust a flat centering beneath the joists, and
form the ceiling by the simple operation of pouring a com-
position in upon it, than the tedious process involved in our own
treatment of lathing, and applying the various coat 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 occur-
rence of serious conflagrations in France is mainly attributable to
the fact that the plaster ceiling is not applied until after the sub-
sequent losses by fire, the discredit 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
sure to justify an attempt to improve our present order of
building; 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
develop constructive or artistic talent.

Mr. Christophers felt cast on to offer some remarks upon
what had been called the English system, as the results of con-
siderable experience. He had spoken warmly in favour of that
system when it was first introduced, and still thought well of it, but
this was a matter of 18 months, and it had not been properly
tried. 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 one instance of it which had remained perfect 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
split 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 corre-
spondents suggested, it might be owing to the expansion of the
concrete. Whether the fault was in the cement or in the concrete,
Mr. Christophers, had never had or heard of any failure in the English
system of other modes of finish, and amongst these he might observe
that he had found the metallic l apparent. Owa and Armand
quite successful after two years trial. The ceilings on the French
system were, in his opinion, better than those on the English
system. At the latter the workmanship had been so good, an
there was a serious objection where the plasterers were 1½ to 1¼ inch thick,
while under the flanges of the joists and girders there was no
key at all, and several serious fails 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 mate-
rial was applied to form the ceiling from below. As the objection 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 the floors below. He had not been able to try 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 expedient 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
over-covered with sand; but when the moisture had dried, after 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 1½ 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 Barry's system admitted of the best plans
and carried on in a better manner, and he would 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,
and it did not seem to him that there was any reason for adding 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,
described in the best way. He objected to the course pursued by
Mr. Barrett in his calculations read at the last meeting, and to
the plan he had put forward, which he was induced to bring to the lowest possible figure. Thus Mr.
Barrett made a deduction for an assumed excess of strength, but
he (Mr. Christophers) 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 foundations, even in the country, on a maiden soil, and in a second-rate house in Pull-Mall he estimated the extra cost for the foundations, which were essential in using this solid and massive description of fireproofing, at 20s.

In the Thames Chambers, an extra first-rate building, upwards of 10,000 feet of hooping was required, at a cost of 4/6d. rather more than half of which, or 23s., 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 10l. to 30l. It did not appear, moreover, whether the hoisting and fixing of the joints were included in Mr. Barrett's price. [Mr. Burdett said they were included.]

Then expense was incurred in cutting and trimming the joints for chimney breasts and projections, which in the case of the Thames Chambers, where there were fifty-five squares of flooring, he estimated at 10l. There was the painting the lower flanges of the joints, which could then be varnished in a mastic manner, 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 x 12 ft. = 1 sq. = 4 ft.**

<table>
<thead>
<tr>
<th>Description</th>
<th>Mr. Barrett's price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fireproof floor with cement surface</td>
<td>£6 6 0</td>
</tr>
<tr>
<td>Costing its deduction</td>
<td>£4 14 0</td>
</tr>
<tr>
<td>Add for extra foundation and band</td>
<td>£3 0 0</td>
</tr>
<tr>
<td>License for use of patent</td>
<td>£1 0 0</td>
</tr>
<tr>
<td>Holting, fixing, cutting, and painting—say</td>
<td>£2 10 0</td>
</tr>
</tbody>
</table>

**Cost of timber floor, pegged—Mr. Barrett's price | £8 6 4**

**Excess over cost of fireproof floor | £2 0 0**

**For a Room 20 x 20 ft. = 4 sq.**

<table>
<thead>
<tr>
<th>Description</th>
<th>Mr. Barrett's price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fireproof floor with cement surface</td>
<td>£14 4 3</td>
</tr>
<tr>
<td>Cost of ceiling, 4½ yds.—£1 0 0</td>
<td></td>
</tr>
<tr>
<td>Extra cost of ceiling, £1 1 0</td>
<td></td>
</tr>
<tr>
<td>Extra foundations—£3 0 0</td>
<td></td>
</tr>
<tr>
<td>Extra holes in beam—£1 0 0</td>
<td></td>
</tr>
<tr>
<td>License for use of patent</td>
<td>£1 0 0</td>
</tr>
<tr>
<td>Fitting—£3 0 0</td>
<td></td>
</tr>
<tr>
<td>Wood fillet for carpets—say</td>
<td>£1 0 0</td>
</tr>
</tbody>
</table>

**Cost of fireproof floor, with 1½ ft. battens, @ 2½ | £30 16 6**

**Excess over cost of fireproof floor | £4 3 8**

Up on the whole, therefore, he thought Mr. Barrett's estimates were not to be depended upon.

Mr. C. H. Spurle 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 had employed some years ago to remove from the residence of Mr. Parkes, Holbe, at Eath, more than 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 most instructive.

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 the vicinity of the quarries. They 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 latter 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.B., 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 the remark I mentioned on the last evening; it is in M. Eck's Traité de la Construction, Poteries, Fer, Fonte et Tôle, in two vols. fol. Paris, 1841; in which we will find many very remarkable illustrations of the application of those various materials to purposes which rarely are thought of in this country. It is an extremely useful work, and if it were 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 385, in which I gave a short description of the application of the S-shaped rolled iron: I allude to this because I have reason to believe that the application of this kind of bar 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 1680, in whose work an account was given of the church of San Vitalis, at Ravenna, of the forms 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 Syracuses, 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 formula given by General Morin are as follows: 1st. For the Strength. We, 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 metres and kilogrammes.

Then, calling the height of the bars, or main ribs = b

Their width = a

The load per metre linear = p

The clear span = s

The coefficient of the resistance of wrought-iron = 2,000,000

\[ \frac{a \cdot b^2}{2,000,000} \]

In practice, the load per metre linear usually applied (at least, for the purposes of calculation) is 25-28 kilogs., or about 37 lb. per foot linear; and the joists or bars are placed at distances of about 2 ft. 6 in. apart.

"2nd. In the cases where rolled S rails are used, the height b, and the projection of the flanges 1, and the class of the rails or the size and the projection of the flanges is usually \( \frac{3}{4} \) of b. The thickness of the centre web \( e \) 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 = 2E, and the load bearing on C, and the resistance for this form of section \( \frac{E}{a} \), we have:

\[ e = \frac{1}{3} b + \frac{0.0093 a}{b} \]

in which \( b \) = the moment of inertia of the section in function of the height \( b \), and \( e \) = the height of the neutral axis of the bar. The ordinary..."
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL.

Mr. T. H. Wyatt (the Chairman) stated that the names of two gentlemen had been given to him as wishing to speak 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 gentleman had erected a building five stories in height over all the floors; so the system was a safe and fire-proof; and he would not 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 Massare, Fox and Barrett's floors.

SYMBOLISM IN ART.*

This 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 strain, '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 confratres. 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 tracts, called the 'Christian Year,' and then he goes on to adduce a mass of scriptural quotations, and likewise citations from Boileau and Bozel and other philosophers. Upon the basis of his argument 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 troubled-some 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 nauseam, for it is calculated to bring symbolism, and even religious, into ridicule. Lord Shaftesbury's shake of the head did not mean so 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 patriotic commentator. Water, or any other substance, may mean all these things, and many more, to him who chooses to imagine them; but what art and science, likely to understand all these fantastic applications, and be fastened 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 few, and will be far better understood by the many, and not by the few, for it is to the many that architecture in its noblest

---

monuments appeals. The statue may be secluded in a niche, the picture worshipped by a select body of connoisseurs in the cabinet of a private individual, the vase handed 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 excellence, but those sentiments must be complied with which animate the mass of man, and the mass have never failed in any age or clime to admire the truly beautiful.

So far, the application of symbolism in architecture is narrow, but the body of worshippers is enlarged; though, after all, symbols must to a great extent be local and partial in their application. Mr. White does not in one case look upon his symbols 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 title quoted above:

"... sacra causa spirituali animae densitatem per sacram, quae quasi ex occultis subjectis fidelibus, et quae ipsa est trinus spectatorium..."

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 Parthenon in 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 embalms 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 trust 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 not a part of religious doctrine, but 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 monomanically, 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 decorative details were indications or suggestions, 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 revival of the arts of the Renaissance should not be attributed to the latent significations of the sevior picta, and the multifarious whimiscalities with which brainyach imaginations have filled volumes of commentaries. The truths of religion must be implanted in the mind, they are essentially immaterial, and theological truths can be incarnated in suitable representations only, 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 dedication of the temple from Mr. White's point of view, because the latter cannot 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."

Stated from such a standpoint, 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 incitement of religious feeling, but not so thinks Mr. White. It is not enough that he has commanded and consecrated a church which is not intended to be 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 enchaîned; 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 back to their thoughts, when they go to church, 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 phases 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 visitors 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 seem to be the type of a tree, and how the architetc is duty to transpire, by means of this type and symbolically.

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 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 from the scraps of rich sculpture which are sometimes observed in the gnomes of a retired corner or an unattended 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 proceeding on a false basis, 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 we have not who have been content to be casual, who has even involved religion. We have given this exemption because the architect is not only expected to carry out
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL.

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 removed 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 symbolisation as a recognised catholic principle and practice in art, and when we have done so we are invited to accept their peculiar theological system in its entirety and its minutiae; and if we accept we are led of the same deceptions, 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 symbolisation 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 mould 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, architectural decoration of sacristies and propylaea was 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 colour 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 several occasions, and we have 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, as 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 public 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 Whichead, 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 practical side of the subject. 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, 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 grounds 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 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 taking baths. This is true, but we are not likely to find examples of this. Our readers will be content to take for granted, and even to be excited, 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, wherever they have the chance. We think, nevertheless, that Mr. Cape speaks rather as of the school of mock-modesty, or perhaps as of the offspring of a primitive sentiment, 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 unmoiasted by continental influence, are sufficient to a good purpose, and need not 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 'gentle highway,' while the men and boys gambolled in its waters. There was neither indecency on the part of the swimmers nor indecency on the part of the passers-by. For hundreds of years this great thoroughfare was a chosen scene of pleasure; and the pages of our poets and classic writers describe what many of us have seen, and what the feelings 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 indecency of thought. After the war had ceased, and some of our population had learnt modesty in that great school of out-wars—Pleasant Park, etc.—there was certainly an amazing outburst of propriety—the legs and shoulders of the Englishmen, when 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 by act of the municipal authorities, 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, besides the Thames, the Lea, the Wandle, the Ravensbourne, the Serpentine, and the Thames. On the river being virtually closed, the baths fell off, and of 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 supposed by those who desired that London should possess that great public baths; and when deprived of that, it remained for somebody to take up the idea, and making a bad show as against Paris and other cities. Ardent swimmers sought suburban streams and ponds, but the police
beseet them and drove them back into the town. In time, a
recreation took place; more proprietary baths were opened, and
the mode of taking them improved. A small, likely, was added, in the
course of time, to the propping, when they 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. Cape has 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 considera-
tion 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 unlesseened; 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 enthusiasm received by 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-
determined idea; it was determined by sympathy with the forms of the walks and the opening
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 glass and the mode of housing the materials determined the suppression of the classical
architects. The fine display of the classical columns and
roofs becomes 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 ele-
ments. 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 archi-
tecture, 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
the medieval cathedrals. For, though the winter season draws to a
summer occupation, the wash-houses attached to these establish-
ments 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 prin-
ciple 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 incoherence 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 word "incommodious" is one which the modern swimming bath has but few varieties, and a large area is there-fore left unoccupied for aquatic purposes during several months.
Heretofore such places have been used for casinos, public meet-
ings, and even for prize-fights and wrestling matches, but it is
easy to conceive that improved structures might be so applied
throughout the winter season, and thus produce profitable returns, or
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
day-shops and temporary compartments, and these being provided
and by judicious arrangement a bath can always be so adapted
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 find an official 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 ground model establishments at 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 26,632l., 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 to be achieved is the most substantial 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 as observer; 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 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 economizing, may really ruin the concern. It is a necessity that this question will be addicting the attention of the attendants, fittings, and repairs. Mr. Baly has well shown that it is worth 200l. 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 to be adapted to painting, decorations, and the like, and 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.

Roseo 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 Roseo was found by him in the southern slopes of the Titygas 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 relatively 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 these authorities are elected.

The evidence which formed the basis of this legislation had distinctly traced to the condition of the houses of the working classes the main causes of epidemic 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 evidences of bad sanitary conditions of houses was most striking, 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 drainage of every part.
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 assistance would be rendered beyond the mere provision of the state of sanitation. In 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 the working classes.

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 philanthropical and national, the profits, after the payment of a moderate rate of interest, instead of going to individuals, 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 50 per cent per annum; Capital 100,000l. 85,000l. to be subscribed before commencing works, and 10l. per cent thereon paid up. Power to increase the capital with consent of the President of the Board of Trade, and two-thirds 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 and not in any other 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 “Metropolitan Association for Improving the Condition of 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-closets, substituted for the privy, is situated in the scullery, the door of the scullery 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 17,736l. 17s. 11d. The rooms, which average from 14 feet by 10 feet, 6 inches to 13 feet by 8 feet, are let from week to week, the rent of each set varies from 3l. 6d. to 6s. 6d. per week. The total rents receivable from the various establishments of the Association since December, 1847, amounts to 14,934l. 11s. 7d., of which there has been actually collected 13,494l. 9s. 11d., leaving a deficiency from bad debts of only 36l. 4s. 6d. 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 13,299l., 4s. 6d. have also been advanced on 25 houses, situated in Felham-street and Pleasant-row, Mile End, capable of receiving about 23 families, at a cost of 512. 10s. 6d., and they have decided on erecting another building in Bermondsey, capable of accommodating 108 families, at a probable cost of 14,000l.

The lodgings for single men in London occupied by labourers and artisans being in general as unhealthy as the houses for families of the same class, it was conceived that the provision of.Id accommodation for single lodgers fell within the legitimate province of this undertaking. A lodging-house for single men was erected, capable of accommodating 234 inmates, at a cost of 13,439l. 13s. 9d., and another capable of accommo-

dating about 128 inmates, was purchased by the Society for 1424l. 7s. 7d., being leasehold, at a heavy ground-rent.

Four Branch Associations have been affiliated with the parent institution, namely, at Brighton, Dudley, Newcastle, and Barnstable.

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 1860, the total population in the Metropolitan Buildings, Old Pancras Road, was 728, of whom the deaths were 7, being at the rate of 12 and a half in 1000 of the living.

In 1861, the total population was 800, and the deaths were 9, being at the rate of 15 in the 1000.

In 1862, the total population was 880, and the deaths were 9, being at the rate of 15 and a half 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 1863, 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 (1862), reached a proportion of 21 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 MARIS ALEXANDRE IGLESIAS, 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, granites, or other substance. Secondly, in ornamenting the under surface 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 glue 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 gelatine solution is entirely melted, it

† Shares to the amount of 66,146l., had been taken up to the end of March, 1853.

‡ The building cannot be proceeded with at present on account of a line of houses for which the ground has been purchased. The Directors have also recently obtained permission 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 were mentioned, with the exception of the one relating to the building in Old Pancras Road, being the purchase money of the freehold.

† Reported in the ‘Register of Patent Inventions.’
must be strained through a sieve, so as to remove all impurities; after which it must be warmed to about 60° 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 with 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 through the surface of glass. The process is repeated as often as 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 90° Fahr.

This process is applied to the production of patterns made of different pieces of paper of various colors by the following method: The patentee glues the separate pieces, arranged 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 same manner as above described, or after moistening the backing 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. You may be of any kind, care being taken to select such pieces as are not too 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, gesso, dry sawdust, cotton flock, or, in lieu of the last two substances, of sand. The mixture which consists of four pounds of resin, four pounds of plaster of Paris, half a pound of gesso, and three-quarters of a pound of sawdust. If it is desired to make the composition very hard, the quantity of resin 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 angle and the surface of wood, and 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 to one-half an inch thick, and of a length regulated by the size of the glass, but not less than 12 inches through, and 24 inches through, 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 the mixture of glue and mastic must 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 is 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 surface thereof, as in the case of slate, but only cements them a little way into it.

The blocks or slabs, prepared as aforesaid, are fixed in a wall, or used as a foundation, 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.

Composition for Coating Materials Exposed to the Action of Sea Water*

Edward Oslow Aston and George Germaine, Patentees, April 23, 1853.

The invention refers to mineral compositions, 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 the usual iron ships in combination with paraffin 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 patentee melts together, and thus combine in variable proportions, sulphur, naphtha, and cresote; adding thereto verdigris or acerate 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 prepared. The sulphur, naphtha, cresote, 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 naphtha heated in a separate pan. When these materials are thoroughly incorporated, one pound of acerate 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 naphtha, and afterwards the cresote, at a boiling heat, to secure a perfect combination of the materials. The whole process will apply to the adding of several, they being stirred well together, 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 'Repository of Patent Inventions.'
 STEAM PLOUGH AND DRILL.
ALEXIS DUBRAC, 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 wheel, which covers in the seed and manures, 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, mounted 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 frames 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 bevel 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 with a spur-wheel M, the drills N, N, being the drills for depositing the seed. M, M, 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 P, P, is a series of tin tubes, placed in a line with the drills M, for the purpose of covering 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, movable guide-wheel, to which the fore-wheels of the machine are attached, to admit of their being turned in any direction when so required. V, is a band or cord of the machine that is raised 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 bevel-wheel V. According to the direction in which this bevel-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.

*Reported in the 'Repository of Patent Inventions.'
CONSUMING SMOKE AND HEATING LIQUIDS.

S. M. Belles, Patents, 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 with 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 furnace 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-safe or fire-bar, 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 escape of the gases of combustion, which, in their course through these, will be broken up 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 fore-pump, and the other with the boiler, and thus all the water that enters the latter must pass through the latter admixers, and by absorbing the heat from them 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, and form, in fact, the means where the air from the end of the boiler to the other, and tend to spread the heat 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 evaporating surface is 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, in order to facilitate their chemical union; 2. The application of admixers and heat retainers, whether employed in conjunction with the apparatus for producing smoke, or in furnaces for 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 BISHOW AND HENRY ATTWOOD, Patents, April 29, 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 if 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-flues, by diverting the course of the gases generated in that furnace, and causing them to enter the common flue (where 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 up in brickwork, which forms a flue b, around them of the ordinary kind. Into this flue the flame and heated gases from the furnace 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 flues e, 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 flue 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 iron pulleys, and is thereby brought to the front of the furnaces, to enable the attendant to raise and lower the dampers with facility.

Supposing, now, a bright fire to be burning in c, or 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 g, of the latter furnace, and open the damper i, 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 e, of the former

*Reported in 'Newton's London Journal.'
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 slake 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 hydro-sulphuric 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 supernatant 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, neutralise or decompose, which substances are caused to adhere by means of bituminous compounds or other cement. 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 those of a parallelogram), two feet by one, and six inches deep. The moulds are filled indiscriminately with the said materials, or with alternate layers 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 cut into 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 heavy traffic, wooden planks 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.

Claim.—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.

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 lights 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 when the rocks or islands, from which it is 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 sunken rocks in narrow sounds where the farway is not broad, and where the dangers must be passed very closely; also for harbours at the mouths of artificial harbours, and such like situations. The apparent light at the entrance to Stornoway Bay, in the Hebrides, is erected on a sunken 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 reassemble 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 Stornoway (a Holofshstral apparatus of only 8 inches diameter, with a power of 11,000 candle power) 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 the visibility of the beam of light from the Stornoway apparatus to distances at which it had been seen varied from one to one and a-half miles; distances greatly beyond the wants of the locality.

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, containing or subordinating, which substances are caused to adhere by means of bituminous compounds or other cement. 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 parallelogram), two feet by one, and six feet by one,
SELF-RIGHTING LIFE-BOAT.

WILLIAM BARINGTON, 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. 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, which have a protecting grating G, G, at the upper and lower ends. These valves are fixed on a pivot, 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 ropes 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.
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 pieces, c, are lowered one by one, and bolted together by a diver with submarine armour; the indiarubber 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 guides, g, of which one is shown in fig. 4 of the top of the letter f, 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, k, being on the outermost end of the section already lowered, and the pieces, c, on the innermost end of the section being lowered. When the section is lowered to the point of being close enough 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 expelled, 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 gravel and the sand, it is better to bevel off the lower edge of the face, as shown at f, 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 pulverized in less quantities, and more slowly; sand in still less quantity, but rapidly. Hence, our soils are well adapted to agricultural purposes, and where there is not a sufficient deposit of clay for the purpose, the subsoil may be made to furnish the 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 annual average fall of rain is computed at 45 inches. Our soil, said 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 recommend that the drain should be about more than 200 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 1/4-inch to the yard; the second 50 yards, 1/4-inch; and so on, increasing the grade 1/4-inch every 50 yards. In constructing the ditch thus located, the subsoil should be at least 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 flooding 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 obtrude 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 authorized to state from experience, that the alluvial materials of these ditches is an effectual reformer 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 latch, 1 inch by 4 inches, and 12 feet long. b, the hinder leg, 1/2 or 2 inches square, 3 feet long, and securely fastened to the latch. c, the fore leg, 1/2 or 2 inches square, 3/4 feet long, and securely fastened to the opposite end of the latch. d, the sliding leg, 1/2 or 2 inches square, and 3 feet long; it is graduated and numbered from zero, 5 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 latch 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 brought 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 here-fore 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 a 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 heald 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 Alarm. E. Brown.

Claim.—The inventor does not claim the combination of an alarm-clock with a lamp-lighting apparatus, but the use so far as above described that an alarm being sounded by the clock-worck, 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. R. 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 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 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 in the cutter-heads by 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 connecting the gases and disseminating the same therethrough 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 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.

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.

Annululating 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 green dried out of the surface, and rendered so soft that it can be turned bright in a turning-lathe, or otherwise, preparatory to tinning.


Claim.—The construction of the siding-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.


Claim.—The employment or use of the rods passing through the blocks, in the manner hereinafter described, 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.


Claim.—Curling downward and inward the beams 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.

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 portion of cellular non-conducting substance or substance containing liquid matter.

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 pawl for working up the screw against the edge of the plank.

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 expend proportionally in the direction of revolution of those of each alternate set united 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 curvilinear reverse curve, or in any way substantially equivalent.

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.

Files and Raspers. 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 dogging or choking.

The invention consists in forming perforations or throats to the file, 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.

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.


Claim.—1. The silversing 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 silversing 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 flame or vapour.

The inventors 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.

Ploughs. C. R. Brinckerhoof.

Claim.—1. Combining with the plough-beam, between the plough and the clevia, 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 beveling 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 axlet passing through holes in the bottom part of two common cast-iron lifters or supports, 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-sole.
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.'
large number of cases obviates the necessity for preserving and displaying the models. This index, if prepared by persons fully conversant with the art, would be almost identical with the most useful 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 £40,392 38. The Commissioner of Patents remonstrates against any portion of the Patent Office 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 Secretary of the Interior is, in the 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 exercised as the result of his own 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 proposed reorganization of the Patent Office and the Amendment of the Patent Laws of America, which will be under consideration in the House and Senate of Congress, is one of the most valuable suggestions relative to the re-organization of the Patent Office and the Amendment of the Patent Laws of America, which if carried into effect 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 organization 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 custom accordingly, but who are known in law only as temporary officers, whose appointments are not fixed 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 re-organization, 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 exercise 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, by a special application, 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 expenses, and if the judgment is to extend, and 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 the Commissioner to decide upon the necessity of obviating 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 provide 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 may still insist on the decision of the entire 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 "prima 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 required 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, without any possibility, and lose all his proceedings before the Court for having done 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, or of the invention having been in use; whilst those who acquired 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 is here proposed to be imposed on 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 suit 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 caution the entire machinery, &c. and petrify 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 the justice of the law is such as to allow 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 unconsciously of any previous trial of the same and may be charged with the same before the Court, the ground of having anticipated the plaintiff in his discovery. This would avail him nothing, and should be unable to provide
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL.

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 judgment in anticipation, 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 much aggravated recoupment, is, 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 to mention the costs of the second trial, 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 the provisions 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 punishments provided, it is evident that every provision not warranted 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 feasible invention is 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 aggrieved against it; and also the facility of anti-dating fraudulent evasions of existing patents. Until the statute was enacted, it was with little hope from the Commissioner's office. The Commissioner suggests that this object may be effected by providing for a final and conclusive determination of 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 scrutinized.—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 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 patent processions for its selection 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 favor of the respondent's innocence, and the danger is slight of his being convicted unless truly guilty. He is secured by his supposed innocence, and 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 offense. Hundreds, who have made up their minds to risk the penalty lose by accumulating an estate to subject themselves to the imputation of a crime; and were the stigma of infringing the laws attached to the secret trespasser of his neighbor's patent, the offense might possibly become as rare as others which are committed—not from want, but the mere love of money. Some such improvement 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 1832, 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 1832, under the diversified classes 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 396; 48 of the patents granted related to chemical improvements. J. H. Rand, on a ground of infringement, had 31 patents examined 419, and rejected 100. Mr. Field, in building furniture; 81 to mathematical and philosophical instruments; and 88 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. Scheffer.

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.


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. Those who are not educated 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 appearances of the moon, Saturn, the nebulae, 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 real knowledge, has at last 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 epilogue 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.


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 ready source. As the author has been 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 what 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; white houses for shops and houses are so 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 thus 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 the next few years, there will be a 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.

Sirs—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 sections should be such as to admit of wastewater running through them, and invert 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, \( a - b = \text{rad. of the circle tangential to both.} \)

If the circles forming the arch and invert either do not touch or intersect, then putting \( c = \text{distance of the centres apart} \), \( c^2 + \frac{a^2}{2} = \text{rad. of the tangential circle.} \)

Clarence-place, Belfast, February 11, 1884.

WILLIAM T. MAIER, 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 the above dimensions (p. 7); and also to the results of the experiment sufficiently confirmed the accuracy of the formula of Du Buis, Eyetlwan, Smetham, Preyn, Hawkesley, and other investigators, and as decidedly contradicted the results published in the "Blue Books" extracted 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 determination of the velocity of water admitted 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 measured; and were seldom more than 150 inches (all French men's roads); the differential was very extremely consistent with the mathematical determines successfully resorted to by all practical hydraulic engineers. The experiment by Monsieur Couplet was made on a pipe of 49,290 inches long and 18 inches diameter, the results thus obtained were 130 inches, the calculated velocity was 494 inches, while the observed velocity was 394 inches, differing from the velocity calculated from established formula only about 3 per cent. It was also contended to be extremely small to centralise the jet of water from the pipe; but it was uniformly found that these authorities did great mischief by the widespread dissemination of errors, apparently under Government influence, and by the consequent repression of scientific and practical improvement.

The Paper road was "On Macadamised Roads, for the Streets of Towns," by J. PIGGOTT 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 60 miles of turnpike road, enabled him to express confident opinion upon the comparative durability, expense of making and repaving 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, horse-drovers, at whose expense the roads were made and 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 annoyance and hindrances to commerce arising from ill-rolled or ill-kept, divided-by and noisy streets. The author also laid the greatest stress for the planning of the streets, and showed that the expense 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, without the expense of material and a firmness such as the ordinary method of allowing the street 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 from the footpaths 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 cart-drawn to be buried, was found to be bad and injurious. The labor of the system, and the extra effort 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 horse self system, combined with the use of the sweeping-machines, had been productive of Birmingham an economy of nearly one-third of the materials employed for the construction and repairs of the streets and roads.

Instead of being given on 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 excellent effects; but
prejudices had induced obstinate adherence to the old system, to the annoyance of the public and with the derision of all foreigners who visited us. The actual state of all the leading thoroughfares could vouch for the justice of the criticism of the present metropolitan system.

The greatest amount of wear and tear of macadamised street surface, in this country, was known to be from four to six per annum; and it might be therefore taken at two inches;—the cost of maintenance was fourpence per superficial yard, and that of watering and cleansing was tenevence, giving a total of sixpence per yard per annum. Paving cost fifteen shillings per yard; it required to be done 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 selected and carefully laid, well watered and covered with mud and watered for dust, brushed or swept by machine, 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 frequent streets, of the treatment of the macadam to make it stick; 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 metallophc quicksilver, and preventing the abrasion of the road. It was contended, that the country towns were, for the present, 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 massive roadways. The system of forming streets or roadway, as far as the end, where the main road was the first, and covered with a layer of gravel, was fixed upon, and was then found to be such that no locking was necessary to keep the lock in place, or the bolts from coming out. The bolt, was fixed to a piece, moving upon a centre or pin at the back of the lock. The action of that piece was such as to render it impossible to open such a lock, except by the mere chance or accident of hitting it; there being no possibility of securing 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 permitting banlock, 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 this system, permitting keys had been used, but they required that the lock itself should be altered, to suit any new adjustment of the bit of the key, whereas, in the American lock, the key alone being altered, produced by its own action the corresponding effect. The lock in its locked state, the key coming out, the lock being the own lock-maker, and was able to render the key useless to any other person, by a simple change in the site after locking it. Such lock, whose numbers of permutations varied from 720 to 479,000,600, could be replaced, the number being intended principally for strong rooms of banks, and other establishments where large amounts of property were deposited; they were therefore compounded upon the strength of the lock, which, 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 elicited the principles on which such locks were based, 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 the manufacturers to produce what was really required,—viz., secure locks, adapted to all purposes, of good workmanship, and at a moderate price.

Feb. 14.—The Paper was read "On the Principles and Construction of Locks." By A. C. HOBBS, Assoc. Inst. C. E.

The author's objective 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 the lock, without the use of keys, shorted by the bow and rove, entirely on chance; and that notwithstanding the immense variety of locks already invented, there were really but three absolutely distinct principal features involved in their construction,—so clasped without reference to dates and for convenience of description.

The principle of the lock having a series of fixed obstructions, or wards, and in and about the key-holes, to prevent any instrument except the key being turned in the lock; this principle was shown to be insufficient; however complicated the construction might be, as the wards then 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 extent consistent therewith. But a series of letters once broken once, 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 Brahmin lock, the invention of Barron and of Bird, the Discoverer of Mitchell and Lawton, and the later improvements of Gossbarg and of Gottselli (of Birmingham) and others. Allusion was then made to the great reliance which until recently had been placed on these locks, and an explanation was given of the principle on which all locks of this description could be as easily picked as their predecessors.

The author then considered the necessity of 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 termed the 'variable stumper.' A projection of a certain length, into the bolt, was fixed to a piece, moving upon a centre or pin at the back of the lock. The action of that piece was such as to render it impossible to alter the true position of the tumblers, for on any pressure being applied to the lock, it being no possible movement of securing 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 permitting banlock, 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 this system, permitting keys had been used, but they required that the lock itself should be altered, to suit any new adjustment of the bit of the key, whereas, in the American lock, the key alone being altered, produced by its own action the corresponding effect. The lock in its locked state, the key coming out, the lock being the own lock-maker, and was able to render the key useless to any other person, by a simple change in the site after locking it. Such lock, whose numbers of permutations varied from 720 to 479,000,600, could be replaced, the number being intended principally for strong rooms of banks, and other establishments where large amounts of property were deposited; they were therefore compounded upon the strength of the lock, which, 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 elicited the principles on which such locks were based, 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 the manufacturers to produce what was really required,—viz., secure locks, adapted to all purposes, of good workmanship, and at a moderate price.
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 from any distance,—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. Cotterill's "Patent Oclimax 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 of a match. Soft wood, and that any lock on hard wood, with any number of slides, could be easily picked by the pressure system.

It was explained, that the American permeating 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, the lock meant could be held up to the line by the insertion of a tongue in the keyhole, which would, by the lock remaining in the same position, and the keyhole in the lock, fit into the keyhole, and thus close up all access to the moveable piece under the bolt; and further, to prejudice access to the stumper-piece, it 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 evident that locks constructed on the principle of the moveable stump might be considered secure.

It was shown, that Mr. Gower, who was connected with the establishment of Mr. Clibb, had succeeded very ingeniously in picking three of Hobbs' locks; and was described as having picked a lock, 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 that 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. Here, in 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 lock-makers, would look 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 planter wings. The centre has a rusticated basement, supporting a façade of the Corinthian order, with detached columns and entablature, rising above, and 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 300 to 300 students, with lecture-rooms, &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 dwelling-house and office for attendant. The upper floor is principally occupied by the large studio, which is divided by means of movable 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, others devoted to ladies and gentlemen's 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; Crugbyther, near Knighton; Halse Town, in the parish of St. Ives, Cornwall; Pinfold, near Rochdale; Victory bank, near Oswestry; the new district of St. James, Plymouth; Abertystwyth; Langley Burrell, near Chippenhain; and Portsmouth; rebuilding the parish churches of Llandywydd, near Newcastoe Emlyn; Llandarog, near Llanelli; and Shrewton, near Devizes; enlarging &c., the church at Tisbury, near Hindon; Much Wenlock, near Craven Arms, near Oxfrod, near Sherborne, near Oxford, near Cranmore, near Corbridge, near Lambeth. The committee also increased grants formerly made for re-arranging the seats in the church at Llanwyr, 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, to be erected in accordance with their models. The designs 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. Birdlake 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 on voluntary contributions, and there are several hundred thousand donors of 100£ each. The workmen are Messrs. Joshua Wilson, Arthur Morley, and Rice Hopkins; and the secretary is the Rev. J. C. Galloway, 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, 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 fund, including Mr. Hadfield, M.P., 5000£; Mr. Kehew, M.P.; Mr. Barnes, M.P.; and other gentlemen, 1000£ 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 stowed the two courtyards, with a statue of Martin Luther on the circle tower, and the complete restoration of the great antique Temple of Jupiter, at Spalatro. The plans and drawings for this work are by Mr. Vincenz Andrici, 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:

<table>
<thead>
<tr>
<th></th>
<th>Wooden Ship</th>
<th>Iron Ship</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st year</td>
<td>16,500£</td>
<td>16,500£</td>
</tr>
<tr>
<td>2nd year</td>
<td>16,600£</td>
<td>16,600£</td>
</tr>
<tr>
<td>3rd year</td>
<td>16,700£</td>
<td>16,700£</td>
</tr>
<tr>
<td>4th year</td>
<td>16,800£</td>
<td>16,800£</td>
</tr>
<tr>
<td>5th year</td>
<td>16,900£</td>
<td>16,900£</td>
</tr>
<tr>
<td></td>
<td>82,500£</td>
<td>82,500£</td>
</tr>
</tbody>
</table>

These figures show that the cost of the iron-built ship is very much cheaper than that of the wooden ship.
ence in favour of iron, 780°. A wooden ship of 1000 tons trading to the East, will not carry more than 1500 tons, which, at 51. per ton, to be paid on and home, will give 7500l., while a ship of 1000 tons, built from the same external lines, will carry 1800 tons, which, at 52. per ton, will give 9000l.; and the difference will be 150l., making a total in favour of an iron ship of 1000 tons of 225l.

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 132. per ton, so that the above case is under rather than the favourable opinion of your correspondent.

Eriecon's Cyloric Engine.—After so much has been said, and indeed continues to be said, on this and the other side of the Atlantic respecting Captain Eriecon'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 324° Fahr., the pressure in the boiler would be about 90 l. to the square inch, and the volume of steam in the water. The maximum available pressure of 90 = 15 75 l. to the inch, the force lost by the pump to supply water to the boiler would be equal to 325, leaving 324 profitable power. Now, at the temperature of 324°, a volume of atmosphere measuring at 32° Fahr. 1000 cubic feet would weigh about 100 lb. The power therefore on the feed-pump would be 1/325 part of the power of the engine, supposing it was working against a vacuum; or the useful power generated by the heat is only 5736, 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 32400 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 unheated air, which causes its ignition. It is applied to a double-furnace Cornish boiler of an engine of 30-horse power, and the coals used are all Scottish, and the fuel is burned in three-fifths of the combustion chamber. 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 4 inch thick at the top; and reaching to the underside of the bricks, the spaces vary in depth about 6 inches. The ash from the fuel-pipe, 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 hot, 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 coal. 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 Effinghamplace, Cheamhurt, 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 grade may render it necessary 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 clamping 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 PROTECTION GRANTED UNDER THE PATENT LAW AMENDMENT ACT.**


**2469. M. Davis, Clodhanger-square, Islington—Improvements in the treatment of fibrous materials other than flax and hemp.** (A communication.) Dated October 29.

**2398. G. Shepherd, King William-street—Improvements in the construction of railways.** Dated November 9.

**2388. W. Anderson, jun., and A. W. Murphy, Glasgow—Improvements in that class of ornamental fabrics usually termed "Ayrshire sewed work."** Dated November 16.

**2399. A. Castet, Paris—Improvements in the staining of fibrous diseases in the feet of animals.** Dated November 29.

**2707. R. Briggs, Castleton Mills, near Rochdale—Improvements in weaving and manufacturing raised pile fabrics, and in machinery employed therein.** Dated November 29.

**2773. J. Lord, Farnworth, Lancaster—Improvements in the manufacture of certain articles for ladies' under clothing, and in fabrics for the same.** Dated December 6.

**2927. R. Laverende, Depdord—Improvements in apparatus for subjecting substances to the action of heat, for the purpose of heating, calcining, or combining such substances, or for subjecting such substances to the process of distillation.** Dated December 10.

**2988. J. H. Johnson, Lincoln's-colle—Improvements in moulding, more particularly applicable to loafed wheels.** (A communication from M. de Lourrè, St. Marc, France.) Dated December 18.

**2983. C. Goodyear, St. John's wool—Improvements in the treatment and manufacture of india- rubber.** (A communication.) Dated December 20.

**2984. A. Thomas, Glasgow—Improvements in setting-out and marking the rivet-holes in the plates used in constructing buildings, bridges, boilers, and other vessels.** Dated December 27.

**2985. H. Hughes, Manchester—Improvements in weaving-machines.** (A communication.) Dated December 28.

**3011. S. Barnes, Oldham, Lancaster—Improvement in or improvements in the construction of looms.** Dated December 29.

**3019. J. W. Crowley, Broughouse, 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.


**3089. J. Bernard, Regent-street—Improvements in stitching and ornamenting various materials, and in machinery and apparatus connected therewith.** Dated January 6, 1844.

**7. M. Mason and L. Keburn, Rochdale—Improvements in machinery or apparatus for preparing cotton, wool, and other fibrous materials for spinning.** Dated January 7.


**66. A. B. Bacon, Vos Rebus, Welle-street—Improvements in chimneys and flues of houses, and in stoves to be placed therein, whereby better draught will be obtained, consumption of fuel will be diminished, smoke, fog, and night-damp will be prevented from entering apartments, and the chimney can be readily extinguished.** Dated January 8.

**67. R. Johnson, Luton’s-in-Field—Improvements in machinery or apparatus for elevating in multi-stage elevating power towers; part of the said improvements being applicable to the obtaining of motive power for general purposes.** (A communication.) Dated January 9.

**68. J. G. Taylor, Glasgow—Improvements in writing apparatus.** Dated January 9.

**68. B. Burleigh, Great Northern Railway—Improvements in railway switches and chairs.** Dated January 9.

**68. B. Tippinan, Philadelphia—Improvements in treating fatty and oily matters, chiefly applicable to the manufacture of soap, candles, and glycerine.** Dated January 10.

**69. W. Darlforth and J. Darlforth, Dukinfield, Cheshire—Improvements in mechanisms or apparatus for recording or stopping the motion of locomotive engines and other railway carriages.** Dated January 10.


**69. W. Brown, Bradford, York—Improvements in preparing to be spun wool and other fibrous material.** Dated January 10.

**69. W. R. Rudditch, Wakefield—Improvements in economising fuel, and in the more economical production of light and heat.** Dated January 10.

**68. E. Townsend, Boston, U.S.—Improvements in machinery for sewing cloth, leather, or other material.** (A communication from W. Butterfield and R. M. Stevens, Boston, U.S.) Dated January 10.


**69. R. M. Stanford, Aldegate—Machinery for stamping, crushing, washing, and amalgamating gold and other ore.** Dated January 10.

**69. A. A. Mason, Paris—Improvements in the manufacture of thread or wire to be used for making gold or silver lace.** Dated January 10.

**69. W. Watson, Old Kent-road—Improvements in signalling.** Dated January 10.

**69. H. Bentzenstiel, Swathmore—A machine for sewing or reaping all kinds of corn, grass, clover, or any other field growth and lawns.** Dated January 10.

**69. M. C. Clemp, 1st Benham, Department of Puddlers, now at Aden, South Arabia—An improved guide for the finger-boards of musical stringed instruments.** Dated January 10.

**69. W. W. Waring, Glasgow—Improvements in the production of heat to drying purposes.** Dated January 10.

**69. J. L. Brouers, Poole—Improvements in treating fatty matters previous to their being employed in the manufacture of candles.** Dated January 10.

**69. R. A. Brown, Fleet-street—Improvements in extracting gold from the ore.** (A communication.) Dated January 10.

**69. B. Lister, Scotterow, Northumberland—Improvements in distilling apparatus.** Dated January 10.
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 Fair in May or June next, for the benefit of the Institution, at the Coliseum, 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 Government's Institution, and adjoining Grafton-road, Kentish-town. When completed, there will be eighteen houses, besides the centre building, which contains the board-room, secretaries-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 married 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 one person contain the same, 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 wash-house and laundry for the use of the whole of the inmates. There is also provided a bath-room for males, and one for females. The houses can 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.

8, 9, 10, 11, 12 ... Houses for unmarried women.

13, 14, 15, 16, 17, 18 ... Houses for unmarried men.

19 ... Central building, court, &c., and apartments on the ground story for two married couples.

A, A ... Living-rooms.

B, B, B ... Bed-rooms.

C, C, C ... Entrance porches.

D, D, D ... Water-closets.

E ... Wash-house.

F ... Laundry.

G, G ... Coals.

H ... Bath for females.

I ... Bath for males.

K ... Entrance.

L ... Secretary's office.

M ... Waiting-room.

N ... Back yard, with dust-bins (fitted with cinder-sifter) and coal stores for every house.

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 were all those arts and works which have so much illustrated the nations of Europe, was comprised within the natural and artificial fortifications which inclosed 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 began to occupy the foot of the hill, which the fortifications rendered a citadel, may be considered the more important portion of the citadel; 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 repose 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 M. Beulé discovered a range of steps parallel to the front of the outer gate, and as wide as the principal body of the edifice. The destination, then, of the gates (Propylææ) has been ascertained—after having mounted the immense stairs in question, this open portico formed the entrance to the Acropolis. M. Beulé attributes this grand and beautiful construction to Mnesicles, the builder of the Propylææ, and he is borne out apparently by the disposition and inclination of the ground compared with the site of the Propylææ. 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. Mardonius, 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, spread over the earth and air, and it is by the effort of 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 has it been buried by the earth, 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 Cesar 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 Delphes and Olympus of their statues, he carried this work to the greater part of the country of Athens. Before the close of the fourteenth century, the first Duke of Athens, Nerio dei Acciaiuoli, transformed the Propylææ 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 prison by habituation according to the ideas of the time.

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 Delucius.
The invention of gunpowder has been fatal to the monuments of the Acropolis. Thirty-one years after the event, the Venetians, who had just taken possession of the Morea, menaced Athens with their bombardment, and the inhabitants of the city were immediately set to work with the intention of fortifying still further the Acropolis, and constructing batteries, one of which has been elevated on the ruins of the Temple of Victory, which indeed they ruined for the purpose. The Venetians, however, did not fear the small forces of the Venetians, and the defender of Koroni defeated the Venetian fleet. The Turks, therefore, set to work on the fortifications. The Turks had added in it all their most valuable effects and a large quantity of gunpowder. The bombs themselves would 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 cells and 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 cars 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 Morosini followed the example of their chief, and the ruins of the Parthenon, which only stood on the testimony of Brunswik, 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 view 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 the heads of the statues of the pediments. Besides, the metopes were torn from their grooves, the triglyphs and corinices were broken in pieces by the hammer, their fragments of architecture, capitals, entablatures, &c, were taken away. The Propylae also furnished specimens; two sides of the frieze of the Temple of Vesta, containing no figures, being removed, a part of the Temple of Athena being pilled, 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 vices of the Acropolis of Athens during the last century, and the heads of two hundred and eighty-nine persons, which have escaped 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 for a season of disasters, for at this period the cannon mutilated its marbles and overturned a part of the Erechtheum.

F. P. H.

ON THE STRENGTH OF COMPOUND GIRDERs.

By HOMERSHAW 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 propose 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 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 words, which he deduces from experiment.

1. Within the limits of 6 tons tensile strain per square inch for cast-iron, and 15½ tons for wrought-iron, the tensile force applied to wrought-iron must be 2½ times the tensile force applied to cast-iron in order to produce equal elongations.

2. For tensile forces below 7½ 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 of wrought-iron; and from the last law Mr. Fairbairn infers that this difference of elongation is equivalent to a tensile force of 4ths 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 are 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 2½ tons per square inch upon the cast metal; then, from Table III., we find that the strain upon the true-rod will be about 6½ tons per square inch, and that the set of the cast-iron, after those strains are taken off, will be 6½ 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 cast-iron beam.

"Suppose the beam to be loaded so as to produce a tensile strain upon the cast-iron equal to 6½ tons per square inch; then, in order to produce an equal elongation of the true-rod, the strain upon them must be 6½ times 2½, or 16½ tons per square inch. Here, while the cast-iron beam 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 true-rod, then, by Table II., this will produce an elongation of 2½ parts of the length of the rod; but, by Table IV., the ultimate elongation of 1½ parts of its length. Therefore the cast-iron would be ruptured by extension some time before the true-rod could arrive at a strain of 15 tons per square inch, that is, before they could be strained to two-thirds their ultimate strength.

"Suppose the true-rod 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 true-rod, 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 7½ tons per square inch upon the cast metal. Now, by Table IV., this would give an elongation of 22 inches; but the true-rod had an elongation of 1½ parts of its length. Due to the strain of 8 tons when the beam was in the neutral condition; therefore the total elongation of the true-rod would be 22 + 077, or 297 inches; but from Table II., we find this elongation to correspond to about 18 tons per square inch tenatious force upon the rods. Thus, it appears, that even with the dangerous tension of 8 tons per square inch on the true-rod, 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 true-beam which shall stand 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 heights of beams of the same size, the ratio of the ultimate tensile strength 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 true-rod is here supposed to be one-half the length of the beam, and the conclusions are apparently arrived at on the assumption that the true-rod is extended as much as the under side of the beam. But I fear that the extension of the true-rod cannot be so simply computed even approximately. Each true-rod 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 true-rod 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 true-rod is compressed as much as the upper surface, as for concluding that it is extended as much as the lower surface.

But, in truth, the effects at these two surfaces cannot be considered thus separately. The strain of the true-beam 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 true-beam. 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 the account of the curvature of the part B C, from the first to the second, is less, ceteris paribus, than it would be if B were straight.

The third of the causes in question is the varied tension of the under side 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 greater at its centre, and diminishes to nothing at its ends. Consequently, this flange is much more 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 true 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 true-rod 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 true-beam. This cause has more influence on the extension of the true-beam than any other.

The more inclined the true-rod is to the horizon the greater ceteris paribus is its extension produced by a given deflection of the beam. This may be shown as follows. In the diagram let B C represent the true-rod of a given length and inclination; 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 fulcrums. AB is a vertical, and AC a horizontal line. By deflection B C will be both displaced. Let us suppose (as I shall presently show) that we may let 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 by a distance B b. It is obvious that the more nearly the true-rod is horizontal, the less is the extension compared with B b. If the true-rod were originally actually horizontal, the extension would be ultimately nothing compared with B b; whereas if the true-rod were actually vertical, the extension would be equal to B b.

The inclination of the true-rod, then, is such a counteracting cause that if the effect of the horizontal displacement of C is 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 is seen that the 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 true-beam is, for the curvature of the true-beam does not follow the same laws as ordinary girders; the true-beam having a mechanical action which modifies the elastic curve. The following, however, is a method of approximating to the required result. Let AC the original horizontal distance of the upper end of the true-beam to the left of the lower end a; A B the original vertical depth of the lower end of the true-beam below the upper end b; the length of the true-beam is a after deflection AC = a + b; and the increase of b after deflection = CB = k. Then (bc)^2 = a^2 - b^2; (BC)^2 = (a + b)^2 + (b + k)^2.

The extension = BC - bc = \frac{ab}{1 + \frac{b}{k}}.

Neglecting powers of b and k higher than the first, but A, as has been shown, is usually very small. Therefore, when the true-beam is much inclined we may neglect the first term of the preceding expression. The extension therefore becomes simply equal to \frac{bk}{k}, or compute it by the rule of three, thus:

\text{length of true-beam} = \text{depth of one end of it below the other} = \text{deflection of beam} = \text{extension of true-beam}.

The inclination of the true-beam is not, however, generally so great that we can neglect the first term of the preceding expression.

17°
When C is in the upper part of the beam, a 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 the original, 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 tension had 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, 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 crushed, 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 the beam of fig. 1, the total tension of the lower is equal to the total compressive force of the upper flange; the thickness of the intermediate vertical part being only just sufficient to develop the elastic forces of the flanges equally. But the tensile strength of cast-iron is so much less than its compressive strength, that the angle B' is 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 (BtoC) of the beam? They are, a compressive force in a, a tensile force to the right in a, and the horizontal component of the tension of the right-hand truss (AB) acting to the right. This latter force concurs with and assists the tensile force of the lower flange to balance the compressive 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 compression c, which therefore reduces tensile force of the lower flange would be required to balance.

Having now considered the horizontal effects of the tension of the trusses, 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 the equilibrium of the half-beam. To compute the strength of the right-hand half-beam B to C, fig. 1, we may take moments about a transverse horizontal axis through C. Then among the external forces considered, we have the tension of the right-hand truss AB 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 this is conveniently expressed in the terms of the tension of the truss-rods as "disturbing forces," this is: 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 maxim gives 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 cases, 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 a disturbing force. 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. In the opinion of Mr. Fairbairn (p. 45), 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 so essentially from his authority, I would submit that catesia parvus 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.

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 to 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, 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 set 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 a' d', 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 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 a' ought to exceed that of d'. Indeed, this proportion excess of the lower flange would 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'. 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: 0'30 square inch.

<table>
<thead>
<tr>
<th>Number of Experiment</th>
<th>Section</th>
<th>Breaking Weight in lbs.</th>
<th>Nature of Fracture</th>
<th>Ultimate Deflection in inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Small flange downward, with truss of 4-inch diameter.</td>
<td>5,502</td>
<td>One truss broken by tension.</td>
<td>-66</td>
</tr>
<tr>
<td>2</td>
<td>Disto, truss 4-inch diameter.</td>
<td>7,944</td>
<td>Upper flange broken by compression.</td>
<td>-938</td>
</tr>
<tr>
<td>3</td>
<td>Disto.</td>
<td>8,554</td>
<td>Disto.</td>
<td>-79</td>
</tr>
<tr>
<td>4</td>
<td>Small flange upward, without truss.</td>
<td>5,830</td>
<td></td>
<td>-78</td>
</tr>
<tr>
<td>5</td>
<td>Small flange downward, with truss of 4-inch diameter.</td>
<td>12,516</td>
<td>Lower flange broken by tension.</td>
<td>-1'06</td>
</tr>
<tr>
<td>6</td>
<td>Small flange downward, without truss.</td>
<td>3,360</td>
<td></td>
<td>-55</td>
</tr>
</tbody>
</table>

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 Experiments 1, 2, and 3, we observe, that where the true is strong enough to resist fracture when the upper flange is broken by compression, there is a great gain of strength. Comparing Experiments 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 beams. These experiments, then, 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 metal. In page 107 we have for the strength of the latter the following formula, which Mr. Fairbairn states that the experiments on them warrant—

\[ W = \frac{60a d}{l} \]

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 experimented on in the preceding experiments, we must have \( a = 54 \) inches, \( d = 4 \) inches, and \( l = 105 \) square inches, 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 \( W = 60 \times 4 \times 105 - 254 \) tons = 54 tons = 10,412 lb.; whereas the strength of the trussed cast-iron beam, properly placed, was 19,316 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:—

"Whitchall, 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 insinuation 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 Board of Health 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, London; and it may also be asserted, that there is no branch of the profession in which the “hand-book system” ought more thoroughly 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 circumstances; pure drainage can be had, inured, in the name of 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 extortion?

The greatest peculiarity of the Chadwick system 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 formulae, deduced from very limited and very imperfect experiments. These experiments were also, as a matter of course, made with pure water, but applying the 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,” etc., 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 success 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 emporer—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, Strand-place, Oxford-street, Feb. 17th.

"My Lord,—The Commissioners of Sewers and the Board of Health are at issue as to the cheaper and best means of cleaning the sewers of London. The Board of Health advocate the drainage of each house block by tunnel, the several submain running behind the houses, and receiving the sewage of each by a short tunnel branch. They recommend a large reduction of the size of drains hitherto used; and for the wide sewers, and recommend a 4-inch pipe for the submain receiving several of these; a 6, gradually expanding to 9½, and so on up to 20, as the lengths of the submain and the number of branches received by it increase; such drains, to avoid self-sealing, are to be self-closing. The whole system is so contrived that it keeps them clear of deposit; the branches being very short, and running backwards towards the drain behind, instead o
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 upon which there is only a small 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 sub-soil 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 undertaken with great care, as they are expensive to lay, and take up a large space 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 escapes 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 considering 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 depth of the depth of the pipe, which is constituted by the 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 refer to the excellent report of St. Thomas's, Tothill Fields, 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

**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 sewerage described at St. Thomas's, Tothill Fields, 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

* "Report upon the Drainage and Water Supply of Rugby, Nuneaton, Tottenham, St. Thomas's, Tothill Fields, and Barnard Castle." By J. W. Bazalgette, M.E., Engineer to the Metropolitan Commission of Sewers. Published by Authority: 1864.

**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.

**"F. O. WARD."**
The completion of the public sewers may be considered, practically, the commencement of the drainage of the town.

The construction of the 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 sockets and fittings 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, varying 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 18, 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 branches of this, which is laid at an inclination of 1 in 200, now runs merely 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 entering the drain 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 300,000 gallons.

A pump 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 40,000 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; exclusive of the land, which is now proposed, or the additional engine alluded to. That of the public sewers has been about 5000. In these two sums are included the engineer's charges, 1000, but they do not include the cost of the preliminary inquiry and report. The cost of the town survey, 814£, is not yet paid. The cost of the private works, including the laying on of water and destruction of the cesspools, has varied from 8£ to 60£ per house, according to the length of sewer and drain required to be constructed by the owner.

At an average of 8£ per house, the estimate would stand thus:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present water works</td>
<td>£10,000</td>
</tr>
<tr>
<td>Public pipe sewers</td>
<td>9000</td>
</tr>
<tr>
<td>Private works</td>
<td>8800</td>
</tr>
<tr>
<td>Additional engine and extension of water works, say</td>
<td>1200</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£25,600</strong></td>
</tr>
</tbody>
</table>

The cost of pumping is about 300£ 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 16£ per foot run for every foot in depth, or about 9£ per foot run in shallow, 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, is composed of shingle. The present time is about 330 years, 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 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 upon 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 lead joints. The bodies of 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 the one fall from one pair to another 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, 303, and 330 yards. The first portion of the outlet for the first two lengths is a 3-inch stoneware pipe, 73 yards in length: total, 1309 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 390, 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 dropping 245 yards of the pipes, which have a fall of about 15 to 1 in 25, it appears, that out of the remaining aggregate lengths of main line, amounting to 1266 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 private sewers and drain collected the drain into covered reservoirs. The western one is elevated 23 feet above Ordinance datum, and the eastern one 67 feet. Each of these reservoirs is capable of containing about 30,000 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 supply has been kept 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 on the north side of the main road, and the water-supply pipes on the other.

The average cost of the private works has been from 7£ to 8£.
per house; but, in some few instances, the cost of the drainage alone amounted to seven guineas per house. Taking the average at 7l. 10s. per house, these works when completed, will amount to £275s. The public works cost,

For water supply, about ........................................ £220
And for drainage works ........................................ 1000

Total .............................................................. £3200

This sum does not include the cost of the preliminary inquiry (170l.), nor the cost of the town survey, which has not yet been charged. But it includes the sum of 213l. paid for the previously existing water-supply pipes which are now used, and 100l. premium to the owner of the former water supply, and the engineer's charge of 314l, the clerk of works' charge of 50l., and the legal expenses. So that the actual cost of these works to the place will amount to somewhat about 600l., including the survey and preliminary inquiry, but not including the surface or subsurface drainage. The estimate, therefore, will stand thus:

Water supply ..................................................... £220
Public sewers .................................................... 1000
Pipes ............................................................. 275
Preliminary inquiry ............................................ 170
Survey, say ..................................................... 89

Total .............................................................. £6000

The contractors' bill for relaying the pipes last year amounted to 77l. 12s., being only about 7½d. per foot linear of sewer relaid.

We shall complete the notice of this Report in our next number.

HYDRAULIC PRESS.
— DUDSON, Patentee, 1852.*

This ingenious and useful apparatus is becoming extensively introduced as a substitute for the old jack-screw. The advantages possessed 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 wall has been gummed with 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 A, 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 A, by the rod e, acting on the piston f. When the lever is raised, a small spring under the valve A, 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 c, downwards; which brings up 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 k, 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 k, 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 COBURG.
(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 £3,000 thalers, or £800. It is erected from the designs of Hofbeamster Scherzer.

* From the "Journal of the Franklin Institute."
ELEVATION OF GARDEN FRONT OF DWELLING HOUSE AT COBURG.
ON THE FRENCH AND OTHER METHODS OF CONSTRUCTING IRON FLOORS.

The discussion on the above subject, which had already occupied

more than its share of the three previous meetings of the Royal

Institute of British Architects (see Journals, vol. 44, pp. 49, 50), 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

floor to which Mr. Garling alludes during the discussion at the

Institute on the 6th February, viz. gypsum or plaster, from

the quarries near Derby and parts of Nottinghamshire, is very ex-

tensively used for chamber flooring in this district, and its durability,

when properly prepared and laid down, fully equals what Mr.

Garling ascertained. The coarsest description of gypseum is used,

and after calcination is broken down with wooden hammers. It is

kept in a dry state, and when laid is mixed with water to the con-

sistence 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 troweis. It is desirable that the surface

should not be broken by using the floor 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

flooring oil is put on both sides of the joists. Where they have

been set, the boards are 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 extended to important public buildings and public offices, and the

superficies 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 objec-

tion. 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

desireable that a proportion of the plaster should be burnt 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 pave 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 gypseum of this neighbour-

hood 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 com-

position. 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 foundation nor hoop-iron bonding 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 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 pub-

lished in 1840, which he had also noticed when examining the

buildings referred to, as well as those of 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

had given their official letters of recommendation, and it had

been found to be a most efficient fireproof construction; and he had himself found it to

answer all his expectations. Whether this system or the French

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 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

of our largest buildings, especially the Villas at St. Leonards-on-Sea, 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 equaling the best, as they remain for fifteen years without a crack. Mr. Christopher objected too much to the cost of the building, as interfering with the supply of air to the fire-

places. 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, pro-

vided for in the usual way. On the other hand, 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 sup-

ported by just such testimony as could be desired viz., the existence of a building on a large scale erected throughout in the manuer referred to, which has not cost more than if it had been constructed in the ordinary way. The roofs—at 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 inde-

structible." As he (Mr. Wyatt) had before mentioned, the adoption of Fox and Barrett's system in the Willes 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 foundation was necessary in the case. 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 small that they could not bear a much heavier load than 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 unneces-

sary. The objection raised as to the expense of cutting and trimming joists to suit openings and chimney-breases, bore rather hardly upon the system, especially as the patentees took great care that it was their joists and girders which were 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
system should be considered preferable, one important point sug-
ggested itself in the present discussion, namely, that a very heavy
resistance would rest upon them and their successors, if archi-
teers, 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
expose 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 under each joint.
This he had thought proceeded from some chemical
action, but it had been entirely removed by the second coat of
lime whiting.

Mr. Paffworth referred to the letter of Mr. Stevens of Derby,
and inquired what amount of space in proportion to the whole
superficies would be left around a plaster surface to allow of its
expansion. His own experience suggested that 13 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 been left unburned for 30 years, and the expansion of the floor and ceiling had
been left originally to provide for this occurrence.

Mr. Inman (the Chairman) stated that floors of plaster, some-
times mixed with coal ashes, were in general use in large
houses in the vicinity of London about eighty or a hundred years
since, and were a common cause of complaint in some of the experi-
mental courts. Mr. Wyatt mentioned the 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. Boullon observed, that in his experience of Fox and
Barrett's systems, they had never given way, though he had employed plaster of Paris to gage them. From
his remarks at a former meeting, it might be supposed that he
disapproved of this system, but on the contrary, he thought it an admirable system, and by far the best mode of fire-
proofing ever introduced. One great advantage which it pos-
sessed was that of economising height, which was a point of the
the greatest importance in London. With respect to Mr. Christo-
pher'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, he had
proved unfruitful to him, inasmuch as he had been subjected to
an action at law and other difficulties. He (Mr. Boullon) there-
fore contended, that it was the duty of the patentees to ascertain such difficulties 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 pre-
sented 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 acted 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. Carrovasco reminded the members that at the com-
mencement of the meeting 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; yet he still thought that for
practical purposes this system was superior to any other for fireproof construction. He was there-
fore gratified to find, that Mr. Wyatt, after his extensive expe-
rience, did not think the warm approval which he (Mr. Christo-
pher) had formerly expressed in any respect overcharged.
On the contrary, 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
think it necessary 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 14 ft. for fillets to a boarded
floor in the estimate for a room 20 ft. by 20 feet. Mr. Beck, in reply
to Mr. Wyatt, said he had stood in the main storehouse of 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 joints before the con-
crete was laid 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 and no expense 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 Wiltse Asylum
may have cost some years ago, when iron was at less than half its
present price. Mr. Christopher's estimate of cost, he (Mr. Beck)
ought to have entered upon the subject if Mr. Barrett had not endeavoured to show that his fire-
proof 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 "exhaust strength,"
and this deduction was one which he (Mr. Beck) thought quite unwarrented, because if the strength of the floors were propor-
tionably 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 system of construction, which had 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 gentle-
man 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 joints, the use
of the license, &c., were fair and moderate additions. Careful-
d detailed accounts had been kept of the recent buildings erected under his direction to test the result, and from these he had quoted. He (Mr. Wyatt) had no doubts as to the justice of Mr. Bar-
nett's 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 in Northwoods the con-
crete 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 stone
was used, which had failed, as before described. New, although
this question had been discussed chiefly with reference to floors,
he appeared to him that the roof was the most important considera-
tion with respect to fireproofing, as many buildings had been
ignited through the roof from fires in adjacent buildings, and se-
veral of his members had stated that the cost of the same materials
as ordinary roofs, roofed 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. The
former gentleman said that he thought that according to the
system 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 ladenings
were supposed to be laid at the bottom of the arch as a brick arch
system; they were a dead weight upon the girders, and were an
element of strength; while in his own plan the union and combi-
nation 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 use—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, higher than that of those that have been used hitherto; 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 fire-proof principle without incurring one shilling additional expense. Because some new material—this 4-inch concrete—had been said to be provided at a cost of 3s. 6d. 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, 19 x 13 feet.**

- 144 ft. — 4 in. landing — at 1s. 6d. per foot — £10 16 0
- Iron work, as at page 92 — 3 15 8
- Facing surface and forming cement ceiling, 6d. per ft. — 3 12 0
- **Total** — £18 3 8
- **Instead of** — 7 14 0
- **Difference** — £10 8 10

**Dimensions of Room, 20 x 20 feet.**

- 400 ft. — 6 in. landing — at 2s. 6d. per foot — £40 0 0
- Iron work, as at page 92 — 10 1 3
- Facing surface, &c. 6d. per 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 quality of finish so far however from this, as had been found in erecting a residence for the highest personages in the realm, there was little probability of its occurring elsewhere. Certainly, any kind of decoration that could be combined with the girders 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 beams exceeding 35 feet, and where many of the ceilings were of a highly decorated character. Mr. Tite had also spoken of the possibility of concrete roofing 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 diastase 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 Manchester. One hundred and fifty 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 the introduction of the system of construction of the building, because which, “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 before the Act and the cement concrete and the roof covering without a stain.” Mr. Christopher had adhered strictly to the construction of these roofs, except in that part which in his case bad failed, viz., the finished covering, which he had formed of Portland cement instead of tarred paper and sand, the use of which was prohibited by the Metropolitan Convalescent Asylums Act. It had been intimated by that gentleman that the failure of the 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 asphalt, tILES in cement, and asphalt in cement, had also been used with perfect success, as had been 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 was better to use another material, whether it be of the kind used by 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 30s., 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 was 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 key, being desirous that it be 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. Rhodes Hawkins, 530 squares; Mr. Brandon, 900 squares; Mr. Clarke, 400 squares; Mr. Selvin, 500 squares; Mr. Holland, 1200 squares, and Mr. Piper, 1400 squares—in the aggregate several thousand squares; and it was stated by Mr. Clarke, that out of another building in London, where he 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 letter 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 artistic which I have observed, it has been beyond any other." Mr. Christopher, on the other hand, has also stated, in reference to the ceilings of the building, that 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 letter 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 artistic which I have observed, it has been beyond any other."
2. 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 my 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 regard the expense of the floors being timber as being any disadvantage.

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 lattice in the ordinary way, if your fireproof flooring is employed, 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, plugged in the usual way."
some little expense might possibly have been incurred on that ground. The painting of the joists was by no means necessary. Upon the admission 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. 93), 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 20 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. 96) 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 10s. 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 74s.; while an ordinary slated roof with ceiling, would have cost 232s.; and a lead roof would have cost 300s." If the cost of an additional covering of metallic lava (46s.) were added to the cost of the roof with a cement surface (74s.), the total cost would be 114s. against 332s., showing a saving of 118s. or 3½ 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. Scotts 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. Wyant 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.

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.

Mr. Paworth 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 1782, 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 barrier, 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 3000l. 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-sash 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. Ismay (the Chairman) reminded the meeting of the different effect which fire would produce on timber and on metal, from the former being a non-conductor 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 work. Experience had shown that in the event of a fire breaking out, the work would be saved if the attic was left within the timber. Let an hour, and to aid in accomplishing this, the Building Act had wisely restricted the cubic 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 gentlemen 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 Bancroft's patent may probably be explained by the fact. Mr. Christopher's patent has been most successfully applied 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 provision and cost of execution, while the Attics are smaller, confined to the back and fronts with small piles of separation, and many difficulties of construction, demand extra fees.

The long improved party walk, 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 dwelling-houses, compared with the large dormitories and corridors in Attics, 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 buildings. Mr. Christopher thinks that these difficulties are not such in Northwoods, situated in the midst of a park, or to the buildings which Mr. Wyatt, Mr. Gass, and Mr. Knowledge are to consider. 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 architecture which have so deservedly won our admiration, 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 advances of modern industry have been created by mechanical contrivance and experiment, little aided, it must be confessed, by science.

In making thisobservation, we intend the word science to be taken in its true sense—systematic knowledge. The word is apt to be confused with art, which has become a synonym for the mechanical science of inventions or systematic knowledge of the more mechanical science of inventions or systematic knowledge of a mechanical science. Unless newspaper reporters be fallible, there is never a vessel launched, never a screw propeller receives a fresh twist, never a new fire-escape rescue people from houses on fire, never a fire-extinguisher supplies a prepared configuration, but "scientific gentlemen" are present to witness the experiment. Let us not be supposed to underrate these advances. 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 becomes systematic and exact. A man may be acquainted with all the forms of screw propellers which have been ever devised—he may know the measurements of all their strange contraptions—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 methodized knowledge which constitutes science, properly so called. So long as the facts of any subject are undigested and its principles speculative, it is with the same confidence objected 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 on the old adage: "Nature shakers 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 paradox of the "radical fluid" 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—"vita viva" and "vita mortua," as they were figuratively termed,—concerning which the controversy was not settled till the metaphor was explained. 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 everyday life, for obvious reasons, frequently affords no means of expressing such results, and all the deficiency has been supplied by the technicalities by 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 sciences have 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 most strikingly confined to the last fifty years. 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 different conditions of loading? The influence of the wind on a ship, the effect of 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 action of a screw according to its 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 the practical man has solved the solution long ago in an infinity of ways. Fish, of divers forms, simply glide through the water 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 we have not the best possible engineering science and mechanics. 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
laws of equilibrium and motion are essentially founded on simple
principles respecting action and reaction inferred from experi-
ment, but not actually derived from it, because we are in no case
example of complete rigidity and complete equilibrium. These
principles are so simple as to appear truisms, and yet so
fertile that on them are based those magnificent systems of inves-
tigation—Statics and Dynamics. But the fertility of these prin-
ciples is greatly increased by the manner in which these systems
are applied, as we have said, by the abstraction of various extraneous
circumstances. Consequently, the systems of Statics and Dyna-
mos are limited two ways—first, they may require the abstrac-
tion 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 pro-
blems.

Now, both these cases occur in practical mechanics. It is con-
tinually requisite, on the one hand, to consider molecular forces
and displacements which Statics and Dynamics originally ne-
eglected; on the other hand, it is requisite to investigate the
operation of forces of which the number alone affords an in-
separable 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 concept of force; but the course to be taken is not the
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
greater difficulty which remains.

Is there not, then, it will be asked, sufficient zeal for experi-
mental 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 inven-
tion, or to ascertain the powers of some machine, material, or
structure—rarely to obtain inductive laws. The impotence 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 fact, but not of the principle of obtaining the knowledge; for nature
seeks the question before us is this: that the very knowledge which is
really wanted, experimenters almost universally neglect as value-
less; 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 on course of its elastic forces, and these are of several
kinds. There is the linear elasticity, resisting change of figure by
bending or stretching; there is cubic elasticity or cubic,
resisting change of figure by torsion or tangential displacement;
cubical elasticity, which resists change of volume by increase or
diminution of diameter. 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 might result in the construction of the vertical sides of such a structure as the
Megalithic. As yet, the absences 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
are available conceived to be. The proper course in this, as in
other mechanical investigations, would be, that the experimenter
and co-operator should be in constant communication respecting
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 true problem is to keep the solu-
tion 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 by the motives and constraint of those
valuable Societies whose purpose it is to promote the advance-
ment 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
methods of the division of labour. There are many mathe-
maticians 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 exper-
imental 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
important results, and direct research into the cause of such
laws, 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 devous paths by which scientific knowledge is most
frequently obtained, or to the distrust of those who are ignorant
of the mathematical instruments employed. 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 myriad of whirling orbs which
rush through space with far and faster than eagle's flight, mar-
shallled 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 not independently 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 ways and
marks that had been previously placed in that path by the hands of the
experimental philosophers. How many long years of unwearied
toil did it cost Kepler to achieve for himself the glorious title of
Newton? To the practice of the mathematical investigator the
problem about the sun, known as Kepler's Law, 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 dis-
coveries 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 conse-
quence of Kepler's Laws. In like manner the path of the math-
ematical 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 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 immaterial and
desultory inquiries by which the present mechanical investiga-
tions are almost universally characterised.

Besides 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
the preceding paragraph are often of such a nature that very
exactness necessitates the use of excessively complicated
formulæ. In the present state of knowledge, science would
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 machines, which the experience of the world, at least, must lead us to suppose to be verified 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 demonstration of the real a"d 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 mathematical presentation of the principles of statics, 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 a statement of the laws of the motion 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 extensaries, the laws of attraction, and the particular Velocities, in each chapter, these chapters, in their 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 forces in bodies at rest. The laws of the equilibrium of a point owing however, we apprehend, to be independent of all experimental results, and to be deduced 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), "that the weight always tends to descend, if there is a 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 other displacement of the system from this condition, 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 obvious than the proof Mr. Todhunter gives of the virtual motion 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 science at Cambridge is the recent improvement of the University class-book. 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 credit of such improvements.

The "Treatise of the Steam-Engine for Practical Men," by Messrs. Hans and Gower, 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 resistance, 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 commend, as liable to occasional error and error, the method of generating the rules and the reasons for them together; yet the difficulty arising from this method seems to be merely typographical. We shall be inclined to think, that if the rules were prefixed by the investigations from which they are deduced, the practitioner would be assisted in apprehending their more complete effect 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 arithmetical. 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 of the paddle from the centre of the wheel. We cannot however 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 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 excellences to render it an indispensable work. 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-sectorians, 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 representational quality.'" Now this being the definition given by a person I would venture to ask in what way I am to be considered as his "co-sectorian"? 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 that no one has been able to give a definition of Symbolism, 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 disbelieved of the idea. And as your Reviewer concludes the question in italics, 'Is the artist a symbolist?', 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 forward or rear wheels are on one of the insulated rails, the hind wheels on the other, the electric circuit (provided the drawbridge is closed) is completed through the bell. In fact, it is so arranged 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 unassuming; 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-rolled 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, by the simplicity of the apparatus and importance of the result to be obtained, thereby recommending 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 replaced 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 now comes from the spot where he is as soon as it is beyond 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

* From the "Journal of the Franklin Institute."

† As soon as these objections were proposed to the inventor, he suggested a mode of obviating both, by permitting the end of the magnet coil on a rod to be removed from the cow-catcher, the other rod projecting similarly from the hinder frame of the engine, and holding the insulated rail in the middle of the track where they could be made periodically. This would make the wire 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.

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 z, Fig. 1. Fig. 2.

will be so attracted as to release the hammer y, which will be acted upon by the spring s, so as to strike the bell b. The shaft to which the hammer is fastened carries with it the handle g, as seen upon the index in fig. 2, so that when the circuit is closed the hand will point to "OK." When the circuit is broken the armature will fall into its former position by aid of the spiral spring e, 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 f, 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.
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 artist-workmen like themselves, and, therefore, at a cost which would entirely exclude ornament altogether, by the majority of those by whose money the arts are supported. The artist-workman, 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 susceivable, would have recourse for themselves, had he 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 these he has disseminated to the public in connection with a discussion 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 based, and that these are now, I believe, 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 gilds, and the dwellings of the wealthy merchants. In the possession of these lay, or was concentrated, all the patronage and wealth of the various countries and states. They patronized 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 patronize art for its own sake, to rival the glories of the ancient races, those magnificence in matters pertaining to art, history and tradition, handed down and transmitted, whether 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 the Pentelic of old; counsellors and workmen, gnarled and 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, demonstrated 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 artistic ideas 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 by the human mind, with its variety 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,

* From the 'Journal of the Society of Arts.'
largely spoken. No doubt can exist but that the people derived much pleasure and satisfaction 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 belongs to the more luxurious life; it has been said that no nation ever went in for so much ornament as the English, and that at an expensive rate. Hand labour is in all civilized 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, and thought that exhibit was a high point of art, and in this idea they were gratified. Not so with England and Englishmen, existing under a government which is freedom itself, with an equalization 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 of finding, under such circumstances, works of art wrought by the hand for 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 other materials; and consequently the prices were correspondingly very high and very exorbitant. Through this, 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 progress: we have one of the most rapidly growing states in the 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 persons turns up his nose at a pretty thing, rejects it because it has not been made by the hand, not because it is not works of art, but because it has been got out by machinery; getting 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 manufactures without being aware of the difficulty 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 day’s it is not the exceptional ornamentation but the internal workmanship which is the more important consideration; that we make locks which cannot be picked except by Hobbe, 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; none of the most primitive and every one 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 it, and apply what it is, however, 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 admixture of medieval psychology with a high grade of art, to which I have alluded, is a condition of certain most curious 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 an inferior amount of superior truth, and to overthrow our selves, 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 considerations to avail ourselves of it. To select the more tedious of the two is not only to waste time and labour, but it is to render the article, everything is art, whether it be of very fine or very cheap materials, and that for a very high price. Labour is too expensive for us. The life of a great artist 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 upon the life of a great artist, which has increased 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, how perfect in every minute detail is it rendered by the troughs of Elkington! What should we have known of the famous busts, statuettes, lamps, tripods, drinking cups, of the Emperor Constantine, the-century cups, or the urn of the Roman emperor, if we did not possess the knowledge of these existently, 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 reproduce works of art in photographs or medals, and in precious metal, and 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? We are called upon to refuse the assistance which the group of appliances which follows will afford us? Thus Cheverton’s process reduces the cost of a large bust to half a shilling; but this is only done in the case of busts that the unaided eye and hand could never accomplish; or Collar’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 anaglyphograph, improved upon the machine used by Collar, and produced thereby specimens of far greater excellence and size. Need I instance, as an illustration among others, the copies of baso-relievo issued by the Art Union of London. Jordan’s wood-carving machine, with a little hand labour adding the grace touches, produces result which, though certainly not equal to the works of Ghiberti or Verrocchio, may, in a good, 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 Proser 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 Europe by hand. 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 their labours are commonly exaggerated, while our own have been correspondingly undervalued. There is probably nothing more amusing than the contradictions which the advocates of medieval principles display and countenance in their practice as opposed to their theory, and in their judgment of what we call modern art and modern techniques. An apostle, who out-Herod 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 many ways of 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 disibute is contained 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 possessors of station, wealth, and 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 Student to Mr. Simpson's report to this effect, "that the 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 skill added to it." Or, if we shall not 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, and where the 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 degrees blooms every hedge-row flower; the daisy like its purple eye to heaven, and the buttercup things the meadow; it is in the meanest creation 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 employment of 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 Phoenician 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 nitrate; 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 artisan, and artificer, or smith, who was the first of his tribe. Though the Bible does not state how, 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 idea which the Levitical law gave to man was regulated 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 a.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 these words does not in themselves necessarily imply that the objects are said to have been cast, and also their capitals. The knops which encircled the molten sea were cast in two rows, the bases on which it rested and the wheels upon which it moved all were cast. Additional evidence may be adduced as to the method adopted, 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 Succoth 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 speaks of a Conus, of dimensions so vast that it bestowed the entrance to the Harbour of Rhodes; it was made of brass bronze; its height numbered nearly 100 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 result of this research than this report that the great Italian artist 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 great accomplished work. The bronze work in the group of the Centaur and Calydonian Boar; the life of the celebrated Bronze Gates of the Baptistery 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 fill the eyes of the 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 in 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, and the artificer is no longer, as a sculptor, or as a bronze castor, or as a master of the art of 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 know, in the giving of the model being made, 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, proportionally 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, consisting of this wax and the melted molten metal, are spread upon it; on this the features, drapery, and other details are 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. This is then heated upon a flame, until the wax is entirely consumed, and the metal is run. The external surface of the wax model is now coated with loam or powdered crucible, ground with water to the consistency of cement, and applied by a brush all over the wax; this coat follows until it is ascertained that a sufficient thickness is arrived at, after which clay is hæpeed upon this, and the whole covered with bricks, bound together with pieces of iron rod; 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, causes the proper moisture in the mould and expels the air when covered up the top of the mould. After the level of the furnace which maintains 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 removed by the hammer and chisel, the three sides 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 united 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 undercuts introduced, that the operation is attended with difficulty. This difficulty consists in judging as to the number of cores to be employed. These, the artist makes, 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 cores are placed in a position so as to receive 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, whether 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 this method, 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 such being very great. The frequent allusion made to overlaying with gold in the Sacred Volume, in all probability, denotes the time of the Prodigal 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 cast was formed and the difference in strength of these new 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 riveted 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 repoussé method of working metals is, the great amount of effect produced, in comparison to the value of the material and the time; the art was long kept up and continued, 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 accomplish this result. This 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 Shakespeare, 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 Inmates of the Bacchanal, which was exhibited by Le Page, in the French Department of the Exhibition. More, 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 and applied by the hammer and chisel, several side pieces are then cut off, the core 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, resin, and sand, and attaches it to his chasing block, or ball; he then works on the convex side with his chasing tools, with these adding the details of features, drapery, and foliage; any roughness is removed by means of riffles, the work is then polished and thereafter burned, gilt or parcel gilt. In this class of art the Italian gold and silversmiths of the 16th and 17th centuries were adepts. This art was revived in the 18th century by Mary Gostin, 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. Hardman produced many of their most brilliant effects. In my opinion, 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 artisan; 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 jemul moulds for pastypanks, 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£, but which may be had for £6.6s. Also a more elaborate work, of the Renaissance period, with bas-reliefs introduced into it, which, by the deposit system, cost of which could not certainly be less than 200£, but which may be had for 12£ 12s. 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 the greatest quantity of power need be applied, the electric fluid, would not be beyond the limits of the art. Were it necessary, another Colossus of Rhodes could be produced by
its a misery. The truly excellent specimens of statuary which now occupy their places 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 cast taken from the entire article required and then invested 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 conglomeration of metal consequent on the inattention of firemen, nor the chance of an escape from the excavations made by the air, nor yet 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 reliquary panals 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, the goblet, or the sheet music, or half a dozen cherubino 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 metallic mould to be afterwards used. The process requires a mould to be rendered conductive 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 than the use of their own engine which sets it in motion. It was at one time held that composite metals could not be deposited; brass has, however, been successfully 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 under-cuttings in moulds may be made, 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 mediaevalists 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 stamping hammer having a heavy plate or anvil, upon which the metal 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 pommets. The die is sometimes made of steel. Steel dies are 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 to relieve in the model, that is to say, he sinks into the steel what is to relieve in the metal. The work must be done by means of fine tools and little lutes, Riveters, and lutes. 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 tube, and the tube is iron lined. When the tube is in position, the long 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 tube, but it is really cut on what has been described as the raised portion of the pattern. When this is completed, the tube is moved a small space, by a mechanical arrangement in connection with the machine, and 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 inner extremity of which the varnish is mixed in the manner above described. 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 two or more tubes a spiral motion; the consequence is, that the pattern is arranged running spirally up the tube. This kind of ornamentation, 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 a piece and may have been delayed from time to time, it takes 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 etching process. The lines sustained after the plate is enameled or engraved plates or other surfaces, impressions on tissue paper are taken in varnish ink; the surface of the metal to be ornamented is cleaned, 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 way, the same employable 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-link of the impression, and the phosphoric acid is set to action, the line being impressed on the surface 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 asphaltite, and subjecting the article on which the transfer has been made to a degree of heat sufficient to produce fusion of the resin and asphaltite; etching is then done, 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 cost, ease, speed, and facility with which the effect of a reticulated surface, an elaborated, chased, or an elegant scroll or flutted design, apparently engraved, may be introduced on any object. The fact of a soft material imprisoning 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 and the process is unsuited 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 of the day, and the cost of the machine with which the production of the impression of the process is due to Mr. R. T. Sturge, 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 energy and in so many ways. The manufacturer is prevented for every change of ornament, their accumulation would become a very heavy drawback on the capital of the manufacturer.

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 and notion of the invention of the machine 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 by the ingenious machine which 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 design. As the softer metal may have been delayed from time to time, it takes 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 etching process. The lines sustained after the plate is enameled or engraved plates or other surfaces, impressions on tissue paper are taken in varnish ink; the surface of the metal to be ornamented is cleaned, 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 way, the same employable 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-link of the impression, and the phosphoric acid is set to action, the line being impressed on the surface 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 asphaltite, and subjecting the article on which the transfer has been made to a degree of heat sufficient to produce fusion of the resin and asphaltite; etching is then done, 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 cost, ease, speed, and facility with which the effect of a reticulated surface, an elaborated, chased, or an elegant scroll or flutted design, apparently engraved, may be introduced on any object. The fact of a soft material imprisoning 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 and the process is unsuited 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 of the day, and the cost of the machine with which the production of the impression of the process is due to Mr. R. T. Sturge, 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 energy and in so many ways. The manufacturer is prevented for every change of ornament, their accumulation would become a very heavy drawback on the capital of the manufacturer.
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 previous blank sheet of metal, the engraved 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 thereof to be made up. This is done, as in the former instance, by placing the sheet of metal to be ornamented with its face portion, the work passing with the raised or projecting portions in the 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 reverse, 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 previous blank sheet is formed is ornamented by means of portions, which are thereafter bent, stamped, or raised into shape, fitted and soldered together. After trimming and dressing, the plating or silverying is effected by the electro-deposit process; burnishing follows, the tools employed being burnishers made of Female's principle, and copy is then prepared. 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 ornamentation bears a correct proportion to the original steel-plate, and 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 Wase or Fillion; and in the art of engraving, the artist's skill and opinion of the material is a distinct advantage in 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 between the two arts. In the art of engraving, it is the engraver's business to produce his impression upon a piece of lead; in the art of printing, for the same purpose, the process is simply that of producing an impression upon 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 1832; but Mr. Sturgess had in August 1851 printed the two specimens of needle-work and net now exhibited. It is very important to remark, that the English patent for the use of metals was sealed on the 25th January 1836, 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 Worring does not appear to have been taken out until the 12th October of the same year; and this was, in all probability, the first application of metal, and when and all the details of the process were explained at length in the then published specification. In the month of December 1832, I happened to be making some experiments on the process for ornamenting metals. I used various media, impressed the designs, and printed from them. I was at the time engaged in experimenting upon decayed leaves, feathers, &c., with the most perfect success, and as I think by your examination of the specimens which I have printed you will readily admit. As my time is much taken up by the range of subjects which 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. Bradford and Evans, and, until very recently, of Dr. Bronson of Sheffield. In every instance save one, the metal which I have used in the printing in stating the case, I was taken from Britainia 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 details of natural printing. In printing direct I therefore stood alone. Dr. Bronson 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. Bronson had read the 'Athenaeum' 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. Bronson'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, and will ultimately be copied, the result will be more successful, though a want of solidity in the lines (a defect inherent in 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 before you as an expert 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 artists and industrial men 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 Shakespeares to portray the sublimity and grandeur of the unseen world, or express the deep, subtle, and mysterious in the works of nature, we must also have Goldsmiths, Bloomfields, and Clares, who we must 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, Hyltons, Maclines, and Etty, we must have Greaves, Bedgraves, Mulready, 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 lively daisy; near the lordly oak the lathern bows. Let us, then, take care of that art which is intended to penetrate into the houses of the lowly. In doing this, we may I 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. Atkik stated, that from the Britannia metal plate then in the possession of Messrs. Bradfords, he had already had upwards of 176 impressions taken. These leaves were dried; he had never attempted to transfer any in a pulp state.

Mr. H. Cole (the Chairman) said—Of course the simpler the printing the more valuable it was; and it therefore could not be denied that the nature printing of Mr. Atkik had great advantages over a system which he had previously practiced. The paper which he had printed from, on the back of a sheet of paper represented, he said, had already had upwards of 176 impressions taken. These leaves were dried; he had never attempted to transfer any in a pulp state.

Mr. H. Cole (the Chairman) said—Of course the simpler the printing the more valuable it was; and it therefore could not be denied that the nature printing of Mr. Atkik had great advantages over a system which he had previously practiced. The paper which he had printed from, on the back of a sheet of paper represented, he said, had already had upwards of 176 impressions taken. These leaves were dried; he had never attempted to transfer any in a pulp state.
CABINET MAKING.*

Amongst the subsidiary trades connected with internal architecture, those of the cabinet-maker and upholsterer affording other opportunities of co-operation than any others. 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 upon the instructions of the architect. If architects were wise in their generation, they would when called in by the decorators and others to draw up the bills of quantities, and specify the furnishing, propose that they should superintend the furniture and fittings. Some architects, it is true, think 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 they call in the most skilled furnishers; 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 architect superintends the choice of the most blunders, and point 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 responsibility, offer such suggestions to the 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 the department utilitarianism is the predominant style, that the two requirements are hardly to be disinterested, 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 of the house. 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 co-operating to the architect's designs, 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 the arrangement of wood work in chimneypieces. 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 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 open in his panels and ornaments for the requisite doors and windows. The gas-fitter sticks up a medieval chandelier to match a Greek or Roman cornice; and the carpet planter 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 disassociative principles, with furniture and hangings, glasses, ironmongery, and gas lighting, the winds 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 gay and fashionable people in the street form an altogether different and independent 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.

What ground must 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 upholsterer has no business to stick to the architect, 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 the results he desires, 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, he will surely find the same principle can be made of 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 effect thus obtained by co-operation is too little regarded. If the architect plans out certain rooms he naturally thinks he has done enough; he provides four walls, a

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 prepare a design for every ornament and fitting. The recent arrangements as to churches have imposed a liberal limit on the artistic emoluments; and, more, the want 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 enhanced 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 the use of the artificer, whose labour 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 subject of 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 to familiarize too much on the previous knowledge of the reader, neglecting anything essential for the wants of the workman. For the workman, the 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 had lately made in the arts of our workmen, far too little thought has been given to 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 gentlemen have not been sufficiently occupied and required 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, worthless, being simply 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 this master, he seldom attains even 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 therefore get a good education from his partners. He seldom attains 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 thus not what the 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 journeys 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 highest prices of the retail market, from which a long credit rests according to the extent of competition. These middlemen are in the habit of giving 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 impulsion 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 that regard to their employment which 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 these to acquire the knowledge of that practical 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 for the working classes, by the system of designing, 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 pauvre et esgoer, those noble foundations now converted into a few academies and universities. The same 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 institutions for the purpose. The working man's school 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 application—chamber-masters, from whom they receive a little of the instruction, 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 distress of employment. The working man too, has his benevolent society to pay, and has duties on his part, as a citizen and a father, and 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 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
AUSTRALIAN AND COLONIAL RAILWAYS.

In consequence of the state of communication in Australia, South Africa, India, and in some parts of South America, it is evident that 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 various districts to be connected are extensive 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 pass the necessary votes, than the case is put to the people; and 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 case 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 two main lines. The main lines, however, remain to be accomplished, and of these the first 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. It is believed that the necessary labour can be obtained at the same rates and in the same manner as in Canada and in 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. One is by guarantees of interests or dividend, as done by the legislatures 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 grant of land, there is no doubt 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 the concurrence of the government of Victoria, but the concurrence of the government of New South Wales is necessary. The province of Victoria has an extensive part of the coal seams, and it is necessary that the effects of such a guarantee 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 province, holding the lands with, their bounds, are interested in every measure for their improvement; and it is almost needless to say, that all means

master, and which is treated very minutely and very carefully. It is not by means uncommon for the cabinet-maker to pay a considerable price for a quality of wood which is not to be had in England, the narrow breadth is less objectionable; but in purchasing it as a material for furniture, the full-sized wood, although it costs more money, will be found preferable. 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, will be less profitable than planks of a large size, which are the usual practice of cabinet-makers. 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 costs more money, will be found preferable. 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, will be less profitable than planks of a large size, which are the usual practice of cabinet-makers. 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 costs more money, will be found preferable.
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 speculative, 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 average price of 11 per acre would be a considerable bonus on a possible outlay of 3000l per mile, but the very construction of the railway immediately affords 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 3000l per mile run upon the one section only.

<table>
<thead>
<tr>
<th>Ultimate Value</th>
<th>One Section per Mile Run</th>
<th>Two Sections per Mile Run</th>
<th>Five Sections per Mile Run</th>
</tr>
</thead>
<tbody>
<tr>
<td>£25 per acre</td>
<td>£3,000</td>
<td>£6,000</td>
<td>£15,000</td>
</tr>
<tr>
<td>10</td>
<td>£6,000</td>
<td>£12,000</td>
<td>£30,000</td>
</tr>
<tr>
<td>20</td>
<td>£12,000</td>
<td>£24,000</td>
<td>£60,000</td>
</tr>
</tbody>
</table>

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, 1864._

SUPPLEMENTARY VALVE FOR CORNISH ENGINES.

—_Birkinbine, Patent, 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 com-

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

**J. M. Masten, 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 one rail to the other. 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 swings the rails by a crank at the lower end, and changes the vane at the top across the line of rails, overcomes both defects. The great simplicity, and compactness, and economy, 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 infrequently happens. On this switch also it is difficult to arrange lights for night signals.

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 varied, to suit particular cases. If the striking edge of the 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 position will indicate as the vane will point, so as 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.**


[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 so much that is 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 boring, and especially exposed to the action of the fire in those 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 screw.

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 a large iron rabbit were roasting inside. Furnish the same 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 rabbet, connected at its outer end to a slide attached to the cylinder, which in turn governs the motion. This slide runs upon a guide, whose angle to the side of the furnace may be changed by the operator, and the rabbet 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 cylinder from the flask. The internal pressures exerted in the 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 improvement consisting of a lifting 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 cans can be readily attained, consists in causing the can, 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 embraced, but has no hold of the leg when the lever is falling. The point to which this lever shall fall is regulated by a wedge. The cans 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 claps 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 a stream of air from a stream of 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 faces 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 hole is bored 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, when the blank is placed in the die-box, a die is inserted against a cylindrical punch, which punches out the hole, carries the die 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 which, like itself, fills the die-box, and commences to move in the same direction, but with a less velocity. The nut is therefore submitted to powerful pressure between these two dies while still upon 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 as 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 outside is grooved and their interior furnishes to such an 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 dies of the required shape to form the thimbles, and in approaching each other, they bring the form into a state in which the thimbles are entirely finished. 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 dies, 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 metallic operation of spitting 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 the vessel to be spitted. The vessel is placed on a turntable, and 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 grippers 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 grippers between each revolution are turned to lay on or remove nails 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 extending slightly beyond the area covered by the other.

When the gripper ring is stationary these series of dies approach each other, each die giving a blow to the blank presented to it. The last gripper in the series then drops a finished nail, and the first is provided with a new blank. On the movement of the gripper wheel or ring, each gripper 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 system of glass tubes, still embedded, to indicate the extent 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 is in constant operation. Several varieties of syphon gauges 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 going on deck.

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. The end of the hollow manuscript of L. de L., carries a gear wheel which is connected with the rock 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 shaft, and carries on it which takes the place of the rock shaft arm. The first eccentric imparts its usual motion to its rod, and by means of the cog 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 that time avoiding jammed shaft.

In the class of Vertical Engines, 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 connecting rod, the other 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 strapes, 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 second ring, and communicates to the eccentric the motion 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 has been proposed. A French machine, 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 act in turn and in the same position as 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 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 compounds of sufficient quantity for the 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 machinery, or apparatus, by which theexpedient, the sequence 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, in the next Congress, the above 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 which have been granted this session, from 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 cut the circle at one point, the right 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 one of the arms is the first dimension, as the right lines 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 may be used upon which the feeler may be placed horizontally, on the other 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 graduatly brought upon the weighing platform, therefore avoiding all jerking and inaccuracy of measurement of the pendulum. The pendulum registers the excess above 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, 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 its 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-stick works between the grooved circumferences of two pairs of wheels, which, revolving in opposite directions, carry the drill-stick first one way, to give the blow, and then back again. The drill-stick is grasped or held by the two wheels only, and by their circumference of the wheels of each pair being slightly reduced, and the manner in which the former pair is found the drill-stick 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-stick just before the drill is ready to strike the stone. With this principle the machine is so constructed that the wheel 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 obliquity to the direction of the drill-stick, thereby imparting to it a slight screw motion. These machines are very much superior to those heretofore known for this purpose, as they prevent any rapid return motion of the drill. In another of these machines, the drill-stick 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 re-clamps the drill-stock, and it returns by the back stroke of the pistons. 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 the 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 lands 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 of the past year, and their opinions as to the 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 embitter the future consideration and disposal of the cases, 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, Patented, 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 any 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 iron, united together and held by arms A 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 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 center of a boiler, constructed according to these improvements: and fig. 3, a horizontal section of the same. 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 dome C, with an upper pipe, and the chimney 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 H, 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. S, 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 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 by the pipe G, and 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, Patented, 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.

Improved Moulding Apparatus.

Fig. 4

Fig. 5.

Improvements in Steam Boilers

Fig. 2.

Plan View

Fig. 3.
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. 6, 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 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, Patented, 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, 180 lb.; common salt (ground 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 SYMMS FRIDEAUX, Patented, 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 downwards. 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 consisting of the panel of the furnace-door, consists of a series of shutters a, b, c, 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 f, 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 e, which do not incline; r, s, are air-spaces between each series. By means of the slight inclination in opposite directions given to the first and second series of plates f, m, the direct outward radiation of the heat from the fire is prevented although the air has free ingress, and the inclination, being at the angle to the axis of the line of draught, causes 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 fol-lowing 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 k (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 reduced 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.
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 same. If the color of the pigment 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.)


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.

Claims.—1. The employment of a diaphragm with a suitable opening, through which the subject or person is projected 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 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 bevel on the ends of the staves; the second set for equalizing the thickness of the staves at each end; and the third set for cutting the grooves for the beds: 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 must be moved by means of weights the staves, while being wrought, are kept steadily in contact with fixed stops.

Claims.—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.


This invention consists in arranging a series of downwardly-inclined curved openings in the outer case or shell of the ventilator in taking in and directing downward into the building to be ventilated, a current of 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.

Claims.—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 these frustrums towards the centre, 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.


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 a 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 forwards from the guard, as in the figure. And in combination therewith, making the float narrower at the 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 accuracy, and convenience in the carrying on the important operations, the author gave a brief account of the origin and principles of that system. The method of determination of the "mêtre," 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" contained in silver and forming the basis of the ascending and descending series of coins.

The advantages of the decimal divisions and multiples, and of the names applied systematically to all, were asserted, notwithstanding the partial recommendations of the continental, 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 prejudices, and the Frenche nation, the author mentioned its final establishment during the regime of Louis Philippe, and its gradual extension and steady progress subsequently to that period, both in France and in many of the other continental kingdoms. As practical examples, some of the 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 good and just improvement; the great state of preparation in which it was conceived; the difficulties which it had surmounted; the progressive amendments which it had received, as the result of experience during
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL

155

as also its almost indispensable necessity with a view to international postage.

In conclusion, it was suggested that all persons who were interested in the French, either on commercial grounds, from the love of science, or as the friends of peace and humanity, would, of course, be disposed to co-operate 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 that, with due regard to the knowledge and the use of it, not only in Great Britain and Ireland, but in all the colonies and dependencies of the kingdom, and through the example of Egypt, 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 uses to be put in the future by 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 discussed, and then the translation of the present diversified weights and measures into one uniform and decimalially-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, only stamping their decimal value upon them, and thus keeping them in circulation until a new decimal coinage could be prepared. The proposed system would be simpler, could be adopted at a less expense, as 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 adopted by every country. Therefore, all that could be done was to decimalize 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 words of Sir General Sir C. W. were quoted, "The principle of the people is the key to all problems."

The objection made to the use of French terms, such as franc, centimes, metre, &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, Avviudopols 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 numeric fractions and constant recurrence, showed that this objection was much overrated. Even if it was 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 as a basis for the invention of numerals, in the true monetary system, although they called a "Franc" a "Livre." 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 one-tenth of a franc in the other. 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 national price of a standard coin, or, in the case of the penny, was equal to the centime, 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, precision, and certainty, in keeping account, than this decimal system, as it was by frenches 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 show the middle term. In the case of the penny, the 1,000 francs, or even the 1,000,000 francs, is a convenient denomination 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 times, would increase the value of the small coins and postages 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 into red a immense amount of money. 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 proposal was considered to be impracticable, inasmuch as France, Holland, America, and other countries, where the decimal system had been already adopted. The coin of 20 cents of a farthing would equal the centime of France. The exchange with other countries would
be met within 1/8 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 integers into 100 parts or cents, it was contended that no difficulty would be experienced in the general adoption of decimals 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, in that it would facilitate calculation and the receipt and payments of dividends of stock; and thereby, into commerce, into 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 blades set at right angles to the axes of the screws.

The nozzle worked in coils 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, because 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 manoeuvring of the vessel was entirely in the hands of the persons on deck. The fan-wheel and water passages were filled, in the main, with wrought-iron, which could be altered, without expensive enlargement 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 engines and water.

In a trial trip with the Enterprise on January 16th, from Granton to Kirkcaldy and back, a distance of 104 miles each way, the average speeds obtained were, 9-99 miles per hour going, and 9-9 miles per hour returning. The vessel consumed 151 tons of coal 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 40 lbs. in the boiler, with 200-btu gas per hour, and 30 lbs. per inch of the stroke. The consumption of fuel averaged 8 lbs. 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 running 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 nozzle, 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 30 per cent., and leaving a useful balance of 70 per cent. of the power applied to the wheel-shaft.

Reference was made, for comparison, to the performance of Appleton’s pump, and of Barker’s mill, as tested by Mr. W. M. Buchanan of Glasgow. After suitable allowances were made, corresponding to the efficiency of the, wheel, it was found that 33.5 minutes were required to raise 20000 lbs. of water, the following per centages of useful effect were arrived at:—Rutherford, 64 per cent.; Appold, 57 per cent.; Barker, 67.8 per cent.; giving an average 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 the whole indicated power of the engine, as applied to work Rutherford’s propeller, 50 per cent. was lost by friction and other causes, and leaving a useful balance of 50 per cent. Power was afterwards exhibited on a large scale.

The vessel was described as having been built for the “Deep Sea Fishing Enterprise;” with Rutherford’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 Rutherford’s propeller, with preference to 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, with winds of beaufort 3, 4, and 5 miles per hour was sustained, appeared to warrant its being tried on a larger scale.

The chief dimensions of the Enterprise were stated to be: length on dock, 39 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, 42 inches inside diameter, 32 inches outside, and 9 1/4 inches inside, and 2 inches outside 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 compartment, with casing, through two water-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 blades set at right angles to the axes of the screws.
ART IN WASHINGTON.

The capital of this great nation is becoming something better than a mere hothouse of politics. Herefore it has been excessively 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.

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 masterpieces. Corcoran's collection, in particular, is worthy of attention. The mansion is new, and presents a fair sample of the Romanesque style applied to architecture in this country. A picture gallery appropriately 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 Gole'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 admirable. It is a fitting memorial 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 Egyptian 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-corse cornice, apses 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 tube, buttressed walls, bay windows, and vegetation, are used to create picturesque effects. Further delicacy 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 it 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 noble amphitheater, will be a spacious circular hall, the dome, 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 consumed under the auspices of such inventive genius as is at the present head, and under the superintendence of the most skilful workshop in the world, this Capitol will be most highly 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 series of bas-reliefs, "The Last of the Norsemen," will soon receive its due attention. It would be difficult to find a better exponent of the noblest spirit of the young 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 remote regions of our political union, no one who possesses a love for art and architecture can fail to be interested in the progress of this work. The present 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.

The Silver Medal—John L. Thomas, 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 Honour, an Honorary, and an Honorary Graduate—Mr. G. E. 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, isle of Portland."

A Premium in Books—T. B. A. Turrill, for Essay on Timber and Deal, with some remarks on Seasoning and Dry-rot.

A Prize in Books—Mr. F. T. Gompertz, for his Essay "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 will, I trust, feel 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 to point out in what part of the world you may be of service to mankind, and anxious I am to encourage you; but 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 a man who has great talent of invention, and the power of accomplishing many different objects in many different ways. I may once of the Goldsmiths' Company, and therefore have enjoyed many festive meetings in their magnificent hall. I also am occasionally obliged to travel by the railways, and the young gentleman has just now received a prize for his suggestions that the subject has a most splendid 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 greatest 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 his friend, and to his energies 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 offers 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.

I believe there is a great 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 to private, circumstantial, and domestic details. I am glad to add 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 expression he has used towards me, express on the part of the Institute, our grateful acknowledgment for the interest which His 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 the throne. His Majesty has been pleased to favour 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 forward; but I may feel proud of being a favourer of enjoying his personal and courteous 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, I wish the reulation on 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, ever to have had the sight of 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 now stand, to the genius with 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 considerable gratitude for the vast work in which so many architects of great celebrity had preceded him. But alas! in the smith 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 PROPOSED LAWS.

AMENDMENT ACT.

October 17, 1854.

2539. W. Roy, sen., Cross-Alkaliuse, Renfrew—Improvements in the preparation or thickening of colouring matters for printing.

January 1, 1854.

2834. C. N. Michell and A. Leoncini, Paris—Improvements in windows.

January 3, 1854.

17. J. Bernard, Bas-rivet—Improvements in the manufacture of boots and shoes; part of such improvements being applicable to the manufacture of garments.

January 7.

40. J. Rose, Keighley, Yorks.—Improvements in the manufacture of compounds of chocolate, cocoa, and other ingredients for breakfasts and occasional beverages.

January 31, 1854.


January 31, 1854.

149. J. Roundell, Ladywood-lane, Birmingham—Improved fastening to be used instead of buttons, buckles, clasps, snaps, hook and eye, and other similar fasteners.

150. P. A. Leoncini de Fontaineaurose, Paris—Improvements in the preparation and combination of fatty and resinous bodies, and vegetable and other waste, for the manufacture of candles, also in the preparation of a wick to be used for the same. (A communication.)

February 2, 1854.

262. H. Watson, High-bridge, Newcastle-on-Tyne—Improvements in the working of brass and copper into forms, and preparing them for use.

February 2, 1854.

256. P. A. Leoncini de Fontaineaurose, Paris—Improvements in the construction of buildings. (A communication.)

February 2, 1854.


February 2, 1854.

261. J. Rogerson, S. Rogerson, and J. Rogerson, jun., Manchester—Improvements in machinery or apparatus for embossing, cutting, and perforating textile fabrics.

February 2, 1854.

262. J. H. Rose, Wednesbury, Staffs.—Improvements in the manufacture of iron, or steel.

February 4, 1854.

263. G. Mille, Glasgow—Improvements in the construction of steam-vessels, and in the same general class. (A communication.)

February 4, 1854.

272. J. Boydell, Anchor Iron Works, Salford, near Manchester—Improvements in the kind of reverberatory furnace for melting iron.

February 4, 1854.

281. R. S. Newall, Gateshead, Durham—Improvements in the setting up of ships' rigging.

February 6, 1854.

282. A. Smith, Foy's Cray, Kent—Improvements in rollers and mules used in making paper.

February 6, 1854.

283. B. W. Firth, Oldham, Lancashire—Improvements in the method of stopping railway trains, of working break docks, of carrying, and of communicating signals from one part of a railway train to another.

February 6, 1854.

284. A. L. N. Combe Vander Meere, Paris—The manufacture of artificial whalebone, and whalebone paper capable of being used for the making of artificial whalebone and tortoise-shell. (A communication.)

February 7, 1854.


February 7, 1854.


February 7, 1854.

287. J. W. Mosely, Haslford, Staffs.—Improved method of uniting glass and argentile glasses and tubes for conducting water and other fluids.

February 7, 1854.

288. J. Erro, Manchester—Improvements in machinery for spinning cotton and other materials.

February 7, 1854.

289. H. Olding, Lambeth—Improvements in stoves for furnaces.

February 7, 1854.

290. J. J. Leitch, Cattanoch, South Shields, for the manufacture of artificial stone. (A communication.)

February 8, 1854.

291. H. Pope, Edge-water—Improvements in machinery for crushing, grinding, amalgamating, and washing quarts or matters containing gold.

February 8, 1854.

292. A. V. Newton, Chipping-craigs—Improvements in bleaching textiles. (A communication.)

February 8, 1854.

THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL

THE MARKET-HALL AT VOSLAU.
L. FORSTER, Vienna, Architect.
(With an Engraving, Plate XVIII)

Court M. Faure, a gentleman much attached to the arts, has erected a small market-hall at Vosla, 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 wall-burnt yellow tiles, among which rows of red tiles are introduced. The ornaments are from the clay-ware factory at Wagrain.

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 E, 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 scow, 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."

No. 842.—Vol. XVII.—May, 1854.

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 86 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 Dickens 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, deputied 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 dis- semination of the voices 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 those matters being so frequently unseemly 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 edifices.

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. Back, L.L.D., and J. Henry, L.L.D., who fully approved 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.


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 Perry'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 heard the sound of Lake Huron, from the end to the other, 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 street, the sound remains unaltered, as will be conveyed to an audience or a small house 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 Congregational 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 7 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 reverberations vamoosed 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 spread and strength, will give him greater power of voice and more endurance; thus it is, 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 the sound in water being greater than in 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; in water it is prevented from doing anything but coruscating 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 echo in audacity is greatly unnoticed; the echo returns so quickly that the ear receives it 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 a hard surface, 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 indistinguishable to others. The general limit is probably about 30 or 30 feet. It should be ascertained exactly, and it is instructing me that 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 the reflected sounds will be shorter for all his hearers than for himself, as twice the path of the voice and echo; the speaker is thus enabled to distinguish between the paths of the direct and reflected sounds of one of the auditor. The direct echo from the ceiling then becomes an advantage, by strengthening without confusing the sound. But echo acts in 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 of the hall and the ceiling, as well as successive echoes; but when the walls are nearer, the sound becomes con- ninguous, 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 House of Representatives at Washington, and 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 wall, 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 be, made rougher than these natural reflectors. A simpler and more effec- tual method of controlling the echoes from the walls will be to cover them with drapery absorbent of sound. The echo 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 it be shown by the trunks of trees in the edge of a forest return together a distinct echo. The beams under the flooring of the Memorial 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 return echoes. No wall of an inhabited apartment 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 buildings, in heat, is greatly unnoticed; the echo returns so quickly that the ear receives it 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
SAFETY-VALVES.

H. WATERMAN, U.S. Patent, 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.


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 dwellings, 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 dwellings, 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, and the contrivances suggested have been submitted to the test of experiment; they are cheap, simple, and founded in strict accordace with scientific laws.

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 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; 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, 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 found was 90°, 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 fig. 3 and 4, the tolerably certain, as an open window or door almost invariably secures that end. Secondly, the equal distribution of warmth, freed from draughts, which carries up the chimney a large proportion of the heat which should be diffused; but by converting the hearth-plate and jamb 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 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 overheated, 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-passage may be cut off." Mr. Lloyd proposes to provide churches, theatres, concert rooms, and pieces 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. Supporting 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.

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. 7.

Mr. Lloyd also proposes a simple contrivance for the consump-

tion 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 inclining 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 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 ½-inch diameter, affording a heating surface of 1050 square inches; C, is the air-chamber attached to the gas-box A, and through which the smoke-tubes pass; D, 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.

Supporting 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
THE GREAT CIRCLE COURSE INDICATOR.

Lieutenant E. D. Ashe, R.N. Inventor.*

regularly 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
intercepted by it. This moveable arc, called the course indicator,
is fitted with two brass pointers (intended to represent the ship),
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 repre-
sents 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.

CYLINDER WATER-METER.

J. HARTZ, 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 egress 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-epindle, 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 sliding 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

* From the "Nautical Magazine and naval Chronicle."
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-pipe W, fitted into the lever. The slot on this segmental plate is rather shorter than the traverse of the pin in the lever. While on the lever the traverse of the pin is a quarter of 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 all quartz 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 pawl Y, fitted to the T-lever Z, which is secured to the connecting-rod of the valve-epindula.

In measuring fluids by this meter, the fluid to be measured enters by the inlet-pipe W, which receives it from the main, escapes from the outlet B, whence it passes along the outlet pipe, to the opposite 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 a, is opened suddenly, and the fluid is allowed to enter the opposite end of the cylinder, thereby forcing the piston back again, and consequently expelling the fluid which had been collected above the piston; the fluid thus 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; the fluid then passes on to the false bottom end, to the cylinder, so as to be capable of adjustment by an external screw or other movement. The capacity of this 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 55.)

As the Turkish capital lies at the feet of such an extensive mountain range as that of the Hymus, 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 Dahair is now to be alluded to. It is situated one hour's distance from Ejug, and in perforating the soil to the depth of only a few feet, abundant springs of water are found. The mountains of Karamanets, distant six miles from the city, furnish a very abundant supply 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 Chavasse Kiti. In the vicinity of the Adrianople gate is a valley towards the Ponte Piccolo, whose springs have also been collected. The springs of the two hills on which lie the villages of Nifes and Alpe 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 infliction of cleanliness and copious ablations, have given to the engineering works of the Turkish capital; and thus the arrangement 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 special 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 luches, equivalent to 12,587,552 kilogrammes; and computing the population at 650,000, the daily supply for each person amounts to 38.44 kilogrammes, or about 35 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 duties of Mahomet's charitable; 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 foundation; and remaining in the water from the effects of the rains, they receive from the dew 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 Augurs, and presents a resemblance to the fountain of Diocletian. 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 pours from the mouths of several cranes, placed symmetrically at each façade. Inscriptions, apotropaia 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 St. Sophia, appears to be of the same epoch as that of the Seraglio, although it is with less richness and ornamentation. The most striking 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 (1680-1736), Italian architecture had already lost that grandeur of 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 structure, 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 invention of the use of the fountain, for 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 St. Sophia, still exhibit ornaments in accordance with the examples of the buildings of Bruss, Sivas, or Korish 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 ornamental forms is sufficient to represent 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 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 the ordinary forms of geometry. The ornament of the cypress, however, 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 bird's eye.

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 pointed towards the celestial, and the thick mass of that divine flame which animates humanity. It is to be met with on the oldest monuments of Persopolis and Biutun, as also in the miniature paintings of Persian MSS. The cypress is, moreover, the constituent of all the ornaments on Indian tasses, which in Europe are erroneously considered and termed palms. These
so-called palms of Indian cashmeres are, in fact, only diversely coloured cypressars, 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 stones 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-BAUDRATH CROMM, 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 year 1822–24; 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 importance of the city. The new edifice, which was planned 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, proscenium; 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 hypocausta for warming the interior; 20, staircases to the boxes of the prosenium and the roof; 21, lateral portals, which open to the back at 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 promenades, 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. Petersburg, near Marisch. The foundation occasioned much expense and trouble, as a plate of oak had to be previously laid down.

MEASUREMENT OF INACCESSIBLE DISTANCES BY INSPECTION.

By ALEXANDR ALLOOF.*

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 garrison 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 "Allgemeine Bearottsung".

* From the "Scientific American".
THEATRE AT AIX-LA-CHAPELLE.

Ground Plan of 1st Floor

Plan of Gallery Floor
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 "impermeable?" 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 north of the Thames. The meaning of the last paragraph but one, "emprise," has been printed "empire."

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 entered upon without reflection. As the letter is a direct complaint to an insult, by so able a diplomatist as the Lord President of the Board of Health, 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 highest contracting parties, as the very contradictory and inconclusive remarks contained in Mr. Ward's letter appear to reflect all men to be utterly insufficient to base an important decision upon; and especially as that decision conveyed a direct censure upon the publications of the Lords 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 essential part of the general question; considering, also, the few questions, 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 circumstances. The Board of Health must be treated on its 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 advocates 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 method which is the exact reverse of that which exists in the district south of the Thamesnorth of the Thames, east, west, or south, 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 1861, for the drainage of the districts which are north of the Thames, was designed 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.

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, we have now submitted to 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, while others are intended primarily for the purpose of intercepting that portion of the sewage from the districts north of the Thames immediately south of the city, or generally 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 scheme, it appeared to us essential, in completing our scheme, all the various factors should be given a 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 in 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.

The four districts are as follows:—1. Northern high-level area, 14; 2. Middle-level area, 16; 3. Low-level area, 11; 4. Western division, 18; total, 591 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, Clermont, Stamford-hill, Highgate, and Dulwich, on the south, by the Regent's park, Camden-town, Holloway, Dalston, and the Victoria-park; on the east, by the River Lee at Stratford; and on the west by the Edgeware-road at Kilburn.

The district has a natural valley line, defined by the Hackneybrook and Bow river, 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 of water, have been largely 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. 1

II.—MIDDLE-LEVEL AREA.

This district, comprising about 10,880 acres, or about sixteen square miles, is bounded on the north by the southern margin of the high-level drainage area, Willesden-green and Harlesden-green; on the south by Bethnal-green, Old-street-road, Lincoln's-inn-fields, Finsbury, Hoxton, and Oxford-street, Notting-hill, Wormwood-scrubs, and Acton; on the west, by Hoxton-hill, near Farringdon; and on the east by the River Lee, at Old Ford, near Stratford.

Of this area the largest portion is closely populated; and probably its population is nearly forty times 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 town, or through one exception, its middle and eastern portions are provided with main outfall lines, which would be 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 the West and South Western Railway, 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 Baneglah 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 Baneglah sewer. Eastward of the Baneglah, it will become solely an intercepting sewer, and will proceed by the way of Oxford-street, intercepting the King's Scholars' Pond sewer, and continuing the Duke-street circuit, it will join with the Regent-street sewer, thence it will continue along Oxford-street, New Oxford-street, Hart-street, King's-road, Lindernpond-street, and Back-hill, where it will intercept the Fleet. It will then proceed along Bay-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, and thence by George Duke's Boot, into the Fleet, at which point a junction will be effected with the northern high-level sewer, with which it will be carried over the River Lee, 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 as possible the drainage by gravitation at high water. The first branch commences at Curzon-street, Finsbury, and proceeds by the way of Leicester-square, Chancroy-street, Covent-garden, and Lincoln's-inn-fields, and joins the main branch at King's-road, Grey's-inn-lane. The second branch commences at junction with the Victoria-street sewer, 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 111 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 Lee; and on the west, by Kensington-gardens, Brompton, and Chelsea Hospital. The level at which the sewer is to be laid is 20 feet below high water; the sewer is not drainable 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.

Likewise 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 Baneglah sewer at Grosvenor-row, Queen's-row, Chelsea. It passes along Queen-street and Belgrave-street, and intersects the Victoria-street sewer at the western end of the latter, near 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 discharges into the Fleet, by which is conveyed to Old Ford. It discharges into 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 a present-sewer 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-brige sewer; thence it proceeds through Eastcheap, Great and Little Tower streets, and Tower-hill, to the Minories, thence intercepting the Ironmonger sewer, thence by Royal Mint-street, Cable-street, Back-road,
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 westwards into Dock-road, and 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 stations.

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 connect, and lead 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 Benbrooke-street, Vauxhall, and passes along Millbank and Abingdon streets, 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, Cutty-new-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 same will be conveyed to the Thames by parallel lines in a nearly direct course to the Thames, at the outlet of the River Rodling, 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 provided 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 designated 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 those 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 30 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 outlet 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 distant from the Thames. To effect the interception of its sewage, by means analogous 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 means of sewers (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, will be considerable, if not insuperable. We are of opinion that the Western District the adoption of a system not 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 or its cost, of its 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 is, however, fair, we believe, that means will be shortly developed for effecting the purification of the sewage 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 outlet 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 Walling- 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 line 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 affected 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 Kennington Canal, appear particularly eligible for the establishment of Sewage Manure Works. The marshland itself is of itself a great value, and there are 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 desodourisation, purification, &c, and for the economical transit to the marsh 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.

**ESTIMATES.**

Our estimate for the whole of the foregoing works upon the northern side of the Thames is as follows—

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern high level gravitating sewer and branches as given in Report of Mr. Bazalgette</td>
<td>£274,700</td>
</tr>
<tr>
<td>Middle level gravitating sewer and branches, including land</td>
<td>284,000</td>
</tr>
<tr>
<td>Main low level line and branches, including land</td>
<td>162,400</td>
</tr>
<tr>
<td>Extension of high level, middle level, and low level sewers to Barking, including reservoirs, tidal gates, purchase of land, &amp;c.</td>
<td>455,500</td>
</tr>
<tr>
<td>Pumping engines, pumps, engine houses, &amp;c.</td>
<td>120,000</td>
</tr>
<tr>
<td>Western Division, including Acton Line and branch, Brentford Line and branch, land, &amp;c.</td>
<td>123,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£1,378,190</strong></td>
</tr>
</tbody>
</table>

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 roads laid out in the roads have become 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 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 excess of any temporary 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 combined, 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 sewage to outfalls, 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 diverting from them, we have selected the routes passing as far as possible on the least cost, and least inconvenience 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 as soon as possible, and save the sewage 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, so far as practicable, to assign to the purse of the sewer such a rate 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 internal service, from that point to the minimum, is to be facilitated by narrowing 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 in low water.

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 from the river Lea 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 have presented for the middle and low level sewers, and to abandon the chief portion of the line between the Lee 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 suburbs 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 outlets 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. BARALOTTE,
Engineer to the Metropolitan Commission of Sewers.

WILLIAM HAYWOOD,
Engineer to the City Commission of Sewers.

Summary of the Northern Sewage Interception and Drainage.

<table>
<thead>
<tr>
<th>Area of Districts.</th>
<th>Present Population.</th>
<th>Prospective Population.</th>
<th>SEWAGE. Per minute, at 6 cubic feet per head per day.</th>
<th>The Maximum Flow of Sewage, running during six hours of the day, on the prospective Population.</th>
<th>RAINFOLL, running per minute, estimated at 1 inch. of rainfall, at 48 hours.</th>
<th>RAINFOLL, running per minute, maximum sewage, added together.</th>
<th>LENGTH, INCLINATION, AND SIZES OF OUTFALL SEWERS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern High Level Intersecting Sewer, or Hackney Brook ......</td>
<td>8,913</td>
<td>92,050</td>
<td>415,500</td>
<td>321</td>
<td>1441</td>
<td>3882</td>
<td>5816</td>
</tr>
<tr>
<td>Middle Line of Sewer, and Branches ..................................</td>
<td>10,260</td>
<td>782,200</td>
<td>914,500</td>
<td>2716</td>
<td>5177</td>
<td>6554</td>
<td>6455</td>
</tr>
<tr>
<td>Main Low Level Line of Sewer, and Branches ........................</td>
<td>7,100</td>
<td>645,000</td>
<td>682,200</td>
<td>2240</td>
<td>3872</td>
<td>4747</td>
<td>4474</td>
</tr>
<tr>
<td>Aggregate ...............................................................</td>
<td>25,278</td>
<td>1,819,250</td>
<td>2,012,300</td>
<td>5277</td>
<td>9090</td>
<td>13,860</td>
<td>16,555</td>
</tr>
</tbody>
</table>

WESTERN DIVISION.

Brantford Line .......................................................... | 8,000 | 67,000 | 875,600 | 232 | 1803 | 2605 | 5041 | 7547 | 0 2800 | 2640 | 12 0 |
| Acton and Netting Hill Line ........................................... | 3,500 | 79,000 | 178,500 | 274 | 616 | 1222 | 2206 | 3438 | 0 1500 | 1495 | 10 0 |
| Aggregate ............................................................... | 11,500 | 146,000 | 553,900 | 506 | 1919 | 3838 | 7347 | 11,085 |

The districts of the Metropolitan Sewers Commissioners already reported upon, and the cost estimated by Mr. Baralotte, 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. Baralotte at 271,280S. The plans and details were much approved by Mr. Stephenson and myself, at an amended estimate of 300,000S. 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 interfering drains on the north of the Thames (with the exception of the Western District, the produce of which is proposed to deodore and pass into the Thames at or near the junction of the Kensington Canal therewith; divested of its impurities in the first instance, and by the device of obtaining any return by the manufacture of sewage gas—water).

Reverting again to the Reports of Messrs. Bazalgette and Haywood on the interception or deodore drainage north of the Thames, I must unhesitatingly state—that after a very careful examination of the reports and plans, and the elaborate set of schemes 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 cost given in the Reports now under consideration, I do not think, even if the funds were at once obtained, 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 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 interfering 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 Intersecting Drains for the whole Metropolitan district.

**Estimate.**

As to the north of Thames intersecting system, and conveyance down to Barking Creek, instead of a total cost of 1,378,190l., 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:

For the former estimate of Mr. Stephenson and myself, terminating the drainage in Deptford Creek ........................................ £750,000

Extension through Greenwich and Woolwich, to an outlet in Plumstead Marshes .......................... 500,000 — 1,250,000

Making a total of ........................................ £3,000,000.

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 be foiled by any high tides, or any of the events which they 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.

William Cubitt.

January 25th 1854.
ON SMOKE CONSUMPTION.

By C. Gutherie, Birmingham.

All the schemes which have hitherto appeared for purifying the atmosphere of towns seem directed exclusively against smoke produced by burning vitriol, and this is an error. 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 man and animals, but they 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 fissures into main shafts, 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 13a. 4d. per foot. As 3,600,000 tons of coal are burnt in 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, O, we get CO, and HO. The atomic weights of these substances are: C = 12; H = 1; O = 16; N = 14.

Suppose 8 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 CO which will unite with 14 x 2 x 8 = 224 lb. O, giving 308 lb. CO, and liberating 14 x 8 x 2 x 14 = 784 lb. N, altogether 84 + 224 + 784 = 1092 lb. of gases.

The 1092 lb. O will unite with 46 lb. O, producing 45 lb. H, HO, and will liberate 1092 lb. of gases. Therefore, 100 lb. of coal produces 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 fissures, but this should be reduced as much as possible. The not in use should be closed; and if each house were taxed according to the quantity of fissures passing from it, this might be ensured. Also the mouths of the fissures should be placed near to the fires as convenient.

Suppose then the greatest rate would be 2 x 12,810,000 tons per annum. The specific gravity of CO is 1.0077, of HO 0.894, of N 0.77; and for 312 lb. CO, in the shaft, we have 784 + 140 = 924 lb. N, 46 lb. HO, and 312 + 924 + 45 = 1281 lb. of air. Therefore the specific gravity of the mixed gases in the shaft = 312 x 1.0077 + 924 x 0.77 + 45 x 0.894 = 1048.

One cubic foot of air at 72° weighs about 0.1764 lb., and one cubic foot of the mixed gases would weigh 0.1764 x 1048 = 0.1803 lb., and therefore would ascend in air at 35° with a force equal to 0.1764 x 1048 = 0.1803 lb., or 0.1803 x 1048 = 1.803 lb.

This force would produce a velocity of 45 feet per second, or

\[ \frac{e}{f} = \frac{3}{2} \]

where \( e \) is the velocity sought; \( f \) the force producing it; and \( s \) the space passed over = about 0.764 feet. Therefore \( e = 907 \) 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

\[ \frac{a}{2 \times 0.3} = 4 \text{ miles.} \]
That is, the area ought to be about 2.38 square miles in extent, and the saving per mile would then be
\[ 2877 - 1800 \sqrt{57} = 4060 - 457 = 1527. \]

The cost per frouse would thus be 12. 10d.; 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 it, one can regulate 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, so as to reduce the temperature of the shafts to advantage. 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 in that respect is 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,—I saw the taper principle on which the Balloch and Lochy Bridges are constructed, I took an interest in promoting its adoption in the Abercather and in the Nees 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, 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 on the parallel principle, to show the superiority of 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 the same, and the suspended weight of the taper 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 250 tons of tension and 562.5 tons at each point of suspension. In the parallel principle, truthfully, I am 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 x 7.5 = 2250 \div 4 = 562.5. But the usual mode is to multiply the whole suspended weight by the fourth power of the deflection, which produces the same results. Example: 600 x 3.75 = 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 x 3.75 = 750 tons of tension; 2, weight of roadway in tons 400 x 3.75 = 1500 tons of tension; and these products are the 2625 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. Then 100 = 62.5 x 1.58 \div 2.5 = 385.5, so that 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 deflection 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 sustenance of that of the chains, 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, and 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 2500 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 1500 tons less in the taper bridge, and consequently this is an increase of strength to that extent; and 150 divided by 3.75 equals 390 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 explanations—1. In the parallel bridge, 750 tons 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, on the diagonals of 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 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 shown to the greatest extent, and more immediately the bridge 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 suspension point in the taper chain than 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 (2500 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 parallel bridge this is sustained by the roadway itself, and it can 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 roadway of the parallel 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 houses, nearly all built in terraces, are connected by 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 not large; the average was 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 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 extended, the improvements are good grounds for hoping 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 11/2 to 2 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:

<table>
<thead>
<tr>
<th>Diameter of Pipe</th>
<th>Rate of Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 inches</td>
<td>1 in 1022 to 1 in 639</td>
</tr>
<tr>
<td>15 inches</td>
<td>1 in 635</td>
</tr>
<tr>
<td>12 inches</td>
<td>1 in 635</td>
</tr>
<tr>
<td>9 inches</td>
<td>1 in 340</td>
</tr>
</tbody>
</table>

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 stone-ware 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 also man-holes or shafts constructed for connecting 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.

For the provision of ventilation of the sewers has been made by connecting the man-holes of the houses with the sewer, by carrying up the flue from the centre of a garden-wall or the like to the owner, or where the sewer crosses a field, by carrying up pipes

* Report upon the Drainage and Water Supply of Rugby, Sandling, Tottenham, etc. By W. Blackmore, Esq., Engineer to the Metropolitan Commission of Sewers. Published by Authority: 1834.

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 soil is at present into the Moull, 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 new works, and are now negotiating 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's 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 8s. per house; but they have in some instances amounted to 65s. or 70s. per house. The cost of the 6-inch pipes has been taken down for a length of 100 feet into the chalk, and one of 10-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 2 inches in diameter, and are made of wrought-iron pipe. The quantity supplied is the demand of the sanitary pump, which 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 . . . £26,000

The private works, taken at an average of 8s. 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 would 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 these were rather more, and when in fields rather less.

Pipes laid in footpaths and courtyards, every expense included, except the cost of the pipes:

<table>
<thead>
<tr>
<th>Diameter of Pipe</th>
<th>6 ft. Depth</th>
<th>8 ft. Depth</th>
<th>10 ft. Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 inches</td>
<td>0 81</td>
<td>0 11</td>
<td>1 6</td>
</tr>
<tr>
<td>9 inches</td>
<td>0 81</td>
<td>1 24</td>
<td>1 74</td>
</tr>
<tr>
<td>12 inches</td>
<td>0 112</td>
<td>1 24</td>
<td>1 74</td>
</tr>
</tbody>
</table>

The rateable value of the property in this district is about
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL

25,000. A special rate of 4d. is raised to pay off the principal and interest for the public works, and a general district rate of 2d. 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 8d., in order to cover the payment for the survey and preliminary estimates. The water rate appears to be about 2s. 4d. in the pound, varying slightly with different houses.

ST. THOMAS, EXETER, DRAINAGE.

The rated districts of St. Thomas are 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. The water was conveyed to the River Exe by means of open channels 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 footpaths 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 find its way to the River Exe, by the natural means of the land downhill 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 1840.

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 14 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 sewers were 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 from these places considerable distances over the pathways, and along the surface of the streets. 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 accident, or circumstance draws attention to the fact.

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 stream of water, constituting the highway 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 taken for its protection or removal. The 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 20l. 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 700l., have not, up to the present time, been of any practical utility.

There are about twenty to thirty of the houses in the suburb of St. Thomas, which are 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, in addition, two separate 6-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 waterpipes 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, 405 houses drained into the sewers; in September last, 435; and at the present time 460. 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 other two houses, and the inmates are not allowed to avail themselves of the drainage provided for No. 1.

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 separate sewers, 28 not yet drained, and 26 which drain by separate outfalls into the river, and assume that the remaining 558 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. The drainage of the main sewer, and the open cesspool near the railway; 245 instead of 680 so draining in September last; and 168 instead of 408 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 the cost should not be calculated for that purpose, as it 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 20 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 proper execution, the local interest of 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 for a higher price. The charges 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 237l. The average cost of the private works is stated to be 46. 2s. 6d. 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 8s. 5d., 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 £2671

Total £5467

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 to £7000. If, on the other hand, a watercloset was provided to every house—

The private works would amount to £5593
Public sewers £2671

Total £8264

And the surveys and superintendence, &c., would make the total cost somewhere between £9000, and £10,000. 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—

<table>
<thead>
<tr>
<th>Size</th>
<th>Average Depth</th>
<th>Per Foot Linear</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-inch</td>
<td>3 to 4 ft.</td>
<td></td>
</tr>
<tr>
<td>9-inch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12-inch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-inch</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

An additional price of 2d. per foot linear was paid for removing and relaying pitching; 4d. per foot linear for macadamised roads; and 6d. per foot linear for pavements. Most of the footpaths are made with round-stone pitching, and there is but little pavement in the place.

The rates of value of the houses in St. Thomas's is about 5000l., the rateable value of the whole district being about 11,600l. A special district rate of 7d. in the pound per annum upon houses, and 14d. upon land, is raised for the repayment of the money borrowed. A general district rate of 10d. in the pound is raised to cover supervision, repairs, &c.; or, in its stead, a highway rate of 4d., together with a general district rate of 6d. The water rate amounts to 10d. in the pound, and 14d. 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 Plym, a branch of the Exe and Culm, about four miles above Exeter. The reservoir is 120 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. Some of these sewers only are 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 under 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 by 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 construct their cesspools, put up waterclosets, 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 less than half the private works had been in progress 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 private sewers. The pipe sewers and drains vary in size from 4 to 10 inches in diameter.

The following table gives the length, size, and number of the sewers for public purposes:

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Length in Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>500</td>
</tr>
<tr>
<td>12</td>
<td>600</td>
</tr>
<tr>
<td>10</td>
<td>700</td>
</tr>
<tr>
<td>9</td>
<td>800</td>
</tr>
<tr>
<td>8</td>
<td>900</td>
</tr>
<tr>
<td>6</td>
<td>1000</td>
</tr>
</tbody>
</table>

Total 24,695

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 fire-clay 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 summits 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 100, 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 near 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 itself.

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 was conveyed thence, by gravitation, through 8-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 the reservoir was too small for the wants of the town, and this 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 water occasioned by careless persons and children leaving the taps open by a inch, 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 watercourses 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 re-constructed.

The cost of the private works was stated to have amounted to about 54. per house on the average, which, upon 700 houses, would amount in the whole to about $5000; but in many instances there is but one water-course 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, about $6000; those sums include the engineer's professional charge of $977, 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 and reports by Mr. Ranger. Taking into account these additional items, the cost of the house drainage and water sewers to the town will, when completed, amount to a sum of probably, 10,000; 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:—

<table>
<thead>
<tr>
<th>Description of Work</th>
<th>Cost in £</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waterworks</td>
<td>10000</td>
</tr>
<tr>
<td>Public Sewers</td>
<td>2000</td>
</tr>
<tr>
<td>Private Works (upon reduced estimate by being divided amongst a larger number of houses)</td>
<td>3000</td>
</tr>
<tr>
<td>Survey and preliminary inquiry, &amp;c., &amp;c., &amp;c.</td>
<td>500</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£10,000</strong></td>
</tr>
</tbody>
</table>

The rateable value of the property included in the district rated to the works here described is about 6000, and a rate of 1s. 6d. 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 23. in the pound per annum for private water supply to all consumers. The charge for superintendence of maintenance, and repairs, of the double system of pipe and surface drainage sewers, is paid for out of a rate called the "General District Rate," amounting to 4d. 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. 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 village in a distant or 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, limeing, fencing, and watching, and all the 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:

<table>
<thead>
<tr>
<th>Diameter of Pipe</th>
<th>Depth laid</th>
<th>Cost per Yard laid</th>
<th>Excess of Cost for similar Description of Work at Barnard Castle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inches</td>
<td>z. d.</td>
<td>z. d.</td>
<td>z. d.</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>6</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>6</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>4</td>
<td>10</td>
</tr>
</tbody>
</table>

Now, in London, the cost of merely relaying the pavement would amount to from 1s. to 1s. 10s. per yard, which, in most cases, would be far greater than the entire cost of sewer drainage at Barnard Castle, exclusive of the material. But it is also the fact, that the average depth 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 private 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 circumcised 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.

Pipe sewers are more 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 as least as that of the pipe, and of larger dimensions. It is therefore a manifest folly 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 supposed 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 neatness is practically attainable in laying the bricks true than in joining 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 pipes or joints of the house. Again, in 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 of water is considerably delayed 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 ample, and with considerable hydraulic advantage in point of form, for extraordinary ascensions of storm-water. Should any of the numerous substances (such as rags, flannels, straw, scrubbing-brushes, night-caps, 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 the level of the stoppages 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 stoppages made by the size of the working men to enter it for cleaning 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.

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 Dyson and Sons, to Lord Palmerston, respecting the system of pipe drainage at St. Thomas, Exeter.

After detailing the system employed at St. Thomas's and the expenses incurred therein, Messrs. Dyson 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 acres of land, a right of way about 312 feet in width, and a sum not included in the above 16711. 10s. 5d. 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 13 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 waterclossets are of 4 inches diameter, and those carrying off the flow into seinks are of 3 inches diameter.

All privies and cesspools have been abolished, and waterclossets 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 | 23 16 2 |
| erection of waterclossets, or conversion of privies | 23 16 2 |
| into waterclossets, per house | 22 17 1 |
| Ditto ditto private water supply | 0 18 1 |

ON THE DRAINAGE OF BUILDINGS AND STREETS IN THE METROPOLIS

By W. A. Bouillon.

[Paper read at the Royal Institute of British Architects, March 30.]

Is 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 was embodied. 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 it 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, and the hot-headed partisanship of Englishmen, that a matter involving their most important interest, their health, their money, and their pride, which have often been the subject of such principle, 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 in the hands of efficient and able men, and 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 to this end; by abstaining. It is based on 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; it was not within the province 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 a settlement of this question once for all. It is 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 critic is not in the system, or by 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 Mytilene by my friend Mr. Falkerne, which are now on exhibition in the Museum. I learnt from him that there is recent 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 siphons, which are drawn in the ornamental arches of the City, we may fairly conclude that the Pompeians had water supplied to their houses from 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 hypocaust or passage, we may conclude that probably, from a greater fall, better watermanship, and the constant running of water which took place from the fountain in each house, they did not require to be so frequently beded 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 the size of the sewers in Rome. For the purpose by the authorities at Naples to any one so well recommended, as an advocate of the pipe system would probably be, by the Secretary of State for the House Department. At Pompeii there are indications that the same construction as the Romans of under ground drains which exist 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, hallowed to form a series of long arches over it. There are some advantages connected with this that are not to be pointed out in the 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 heavy 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 the municipal occupation of drainage, 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 as the watercourses were covered, and the need of efficient and able men, the system was 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 the poorest company of men, were probably unable to supply, 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 so a large proportion which is useful, when we consider its progressive development, the divided interests which are involved, and the obstacles in the way, and the extensions to the great town which 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 predecessors in retaining and exaggerating the imperfections. 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 readiest discussion, is into DRAINAGE, SEWERAGE, and OUTWALL. DRAINAGE has to be considered under the head of surface drainage, DEEP-BASED DRAINAGE, and HOUSE DRAINAGE. The necessity of subsurface 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 subsurface 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 proposed for by the present Commissioners, who have 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 to its subsurface drainage over almost all towns in the world. The number of the places where water can flow, is 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. Fulbro; the houses are well drained, but the subsurface 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 Metropolitan Commission, it is probable that the 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 gain which, when there is opportunity, arises from the combining the subsurface 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 is given to be properly managed, and it needs to be cleaned 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
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL

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 laid end up will carry all off at the same time; 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 gullies (of which one of the best forms as found by 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 years, and stay away from 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 cleaned of the road-dirt, forgets that the front areas and backyards of the houses are paved, and the basements of the stores and service yards 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 house drainage, we are next to inquire into their capacity 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. Ceasepools are, I believe, no longer contended for. Water-closets are ordered 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 infraction 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; but 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. In my young days, a true incertitude of 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 me in my old age; then, the old drain 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 EIF by EIF 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, 8-inch house drains, and 4-inch combined drains, are now as much disregarded in London as the street siphons at the rear of the houses.

I could give the history of numerous and various individual failures which have arisen, but others will occur to all the members of the London Institution, and I would only add 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 of 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 5-inch drain be quite full of water so as to push the substance in suspension 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 stoppages, and that a population must be thoroughly imbued with the belief that the omission and commission of sins against sewers will cast a weight upon themselves. In distress 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 cake of the matter carried out of the pipe. The grating on the round, 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 semi-circles 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 3-inch for 4 inches, 4-inch for 6 inches, 5-inch for 8 inches, and 6-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 a period of effusive in giving a smoothness of bore as the most expensive glass would be. Too much attention cannot be paid to the bending of the tubes, as the error in the laying of the tubes is not the same amount of error in the laying 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 of half the tube in the middle.

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 should be sent 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 would undoubtedly be the case with either system, 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 inlets 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-closet sink in the back area, if there is one, to set against the length of the drain from the water-closet 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, or 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-closet are at the rear as they usually are) against the frontage, and we have in this to set 15-inch pipe frontage, and one 12-inch 1 piece, diminishing to 6 inches against 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 of an efficient sewer in the street—and of immense importance that their views should not be compelled 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.

When people who build in the country on their own freeholders', there would be no question against a straightened 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 appointment 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 the outfall, they receive increased amounts of drainage from the increased area they traverse; the average of the make of sewerage over a given area of inhabited houses in London has been tolerably accurately obtained by experiment. It is found that 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 too large, and around.

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 could be produced which would answer 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.

The sewers 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 finished, 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 law of resistance) require a larger and larger amount of fluid in direct ratio to the perimeter of the pipe, 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 up on sound hydraulic principles, and we may hope that there is no waste of public money for want of 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 based on all hands, I believe, that till we have a perfect water supply, and our sewers are secured 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 pipe of the water-colour painter, to a lead pipe of six inches, the water-colour painter had 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 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 fles situations, where raking will probably always be requisite.

A system of flushing has been proposed by Mr. Jennings (whose clever contrivance in connection with drainage details, entitle him to the thanks of all architects and sanitary reformers, and of all whose interests are concerned). His plan is that of 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 pipe, and the entire contents of the sewer flushed away with a single action, and 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, as far as the forces can be levered and released, the gate is very ingeniously, 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 Orinals, on which I can say but very little, except that having read digests of all the schemes...
IRON CUSTOM HOUSE, PAYTA, PERU.
Messrs. Edw. T. Bellhouse & C. Eagle Foundry, Manchester
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL.

submitted in competition to the Commissioners of Sewers, I do not believe it was the idea of the Commissioners, 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 might see by the most cursory glance, that he could not get 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 for 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 crotchet 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 drive some 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 22,000 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 3 yards from the face of the building. The roof inclines upwards from each side, meeting at a square platform 33 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 gauge. 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 columns the balustrade 5 feet of 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 enclosore, 60 feet by 30 feet, into which carts can be taken, is entered by a main arches 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 extend to 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.

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 principal 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, the 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.
ON WATER METERS.*

By J. GLYN, 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 necessities 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, and 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 cumbersome; they are inconvenient; they are troublesome to open, and a 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 wit 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, or, what is much worse, 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 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 develop 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 cisterns of the London dwelling-house already mentioned receives and measures the daily supply, and by means of the well-known contrivance called a bell-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 ruled 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 frame or flax 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-job," and other mechanism, which requires some force of head or pressure to overcome. If the force or head of water be considerably below the action occasioned by an equal 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-blade, some are like Appold's pump, and one like Barker's mill, which has ingenious contrivances for obviating friction, for continual lubrication, or for rendering the water in motion the acceleration of the drum or "mill-pot"—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—Masset'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 acts 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 pays, and paying for it by the quantity consumed. It is to be hoped that some water-meter will be found before many years, or, should any thing like its action be adopted 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 M. Hameen 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 indiarubber, 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-pipes. 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 revolved by each revolution of the 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 meters already in action, and I am told that the difference of the delivery at moderate and high pressures is only 5 per cent.
DESCRIPTION OF TAYLOR'S WATER METER

By Benjamin Fothergill

[Paper read at the Society of Arts, London, April 1848.]

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 subordinated 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 considerate comparison of the principle upon which it is constructed, I am of opinion that it is one of the most efficient discoveries that has ever been made for measuring out and duly registering unaccounted quantities of water, &c." Other individuals also bore the same 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 13, 1848, 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 between one hundred and two 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 cylinder, of a size 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 series of small metal balls 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. That 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 buoyant by the reciprocal 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 intake or suction 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 made neutral in consequence, and is brought 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 clock valve, which closes the apertures of the inlet, excepting a small tube fixed in the centre of the clock, and projecting so as to come into immediate contact with the buckets of the drum; the clocks 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 clocks. 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 clock and causing a compression of the stream, so that no water is allowed to pass but what force through the clock 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. In 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 clocks (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 the whole country, it will be universally 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 declare 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, Mr. George Hansom, of Huddersfield. He (Mr. Chadwick) was officially connected with the waterworks, and through 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.

proved to him that that could never happen, as, when the rollers were up on the valve, the pressure in the bag was not 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 York 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 simply 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 that, if it had 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 50 or 60, and a two-inch meter certainly not more than double that sum.

Lord BERRIENDALE (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, had invented 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. FARNSETH, 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 his 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 edgewise through the moving column, and that communicated the 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 onwards. The water entered the meter, figs. 4 and 5, through a grating, and meeting the sides of the inverted cone (o), it was directed towards the axis, from whence it spread again outward towards 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 vane, 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 vane upon the block (e), in a parallel direction against the vane 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 to the water it would be deflected from its course, and would move 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 transmitted to the upright spindle working in a chamber (g), where the motion was reduced several 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
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 fins or wings (e, e), 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 stop 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 Berridale 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. Yarne 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, and wherein the diaphragm under 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 water, and to the registering and indicating apparatus.

Mr. Chrimne, 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 device such as existed in the Siemens' 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 7s.; one measuring 600 gallons an hour, 9s.; 1300 gallons an hour, 5/., and larger ones in a similar proportion. In conclusion, Mr. Chrimne stated that 300 of these meters had been at work during that year, and that there had been no fracture in any one of them, with the exception that eight or ten had been burned during the late severe frost.

Mr. Grevet, 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 endeavored to ascertain 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 Siemens. He had bought four meters of the first, two of the second, and one of each, 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 a substantial board had brought him the meter for free, 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 contained 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. Hardy Chester, as one of the public, expressed his conviction, that it was highly important to the whole population that the water companies should get out of the dead methods, and be able to every day to see 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, as that was the way that everybody was 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 which the man had in his house. 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 water at the price 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, and he had been aware that Mr. Bevan, his eldest son, who had three meters, told him he was saving more than 100£ 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 economic.

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 24 hours. He had nothing to say 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 was the subject at the time. There was no necessity to speak about the amount of water that consumers imagined they used and water companies that 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 four months had been charged for 1000 vessel-loads of coal, and he was sure that the precise amount of fuel consumed 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 measure, 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 be much abused, 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 were not capable of including the quantity of water from which it was ascertained, the average price paid for water by each individual per service-pipe. He calculated it at 6e. per thousand gallons, which was about 60 per cent. cheaper than gas. The average cost of gas to each consumer was about 59 per annum per service-pipe, and he did not believe that the consumption of gas per individual per service-pipe exceed 30c. per annum, in consequence of the number of small consumers.
Mr. Gravely stated that the price of water was about 3s. 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 73s., and to fix it would probably cost 10s. or 20s. more. Now, it was likely that any person would go to the expense of 3s.or 4s. to buy a meter that 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 adjusted by selling the fruit by handfuls? In the case of gas, to make the cheaper meters available to the general consumer, they must be supplied at a cost not exceeding 15s., while the fitting-up should not incur a further expense of more than 2s. or 3s. 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. Yaxs stated, that the meter which he had produced would only cost 35s., 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 of general use.

Mr. Whithers 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 2s. 6d. whereas for water it was only half that amount, or 3s., 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 10s. per annum for their water, and how could the holders of such houses afford to pay an additional shilling or twopence, 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, as the water would have to 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 24s., 5s. or 6s. 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 4s. per annum, being an addition of 10 per cent, on the lowest charges of about 2s. per annum, which would be a very serious impost on the lower classes 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 200,000l., 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 3l. each, which would have caused an addition of 70,000l. to their capital of 200,000l. 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 been in one of Mr. Siemens' meters to be supplied for a 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. Giltt stated, that Parliament had recently insisted that there should be a constant and continuous supply to the houses of the metropolis, and that would probably not amount to the expense 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. Friesa (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 8l. 8s. 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. Scovr 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 1l. per annum for the benefit of 3l.

Lord Berinale observed, that the objection to the cost of the meters he thought of little moment, as $3l. 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 E, and thence reacting on the bucket F, 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, thus giving additional force to the action of the water in its discharge over the buckets E. 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 in relation to their object; they being to the best of our knowledge, at least, 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 damaged, without the whole engine being out of commission, the invention will not be greater than that ordinariness of thought.

The inventor 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. Mauldby 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 G-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 pumps being worked 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 equalized, and the injurious effects that might arise through leakage are prevented. The feed and blige 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 object 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 those, 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, and fig. 3 a vertical section. The A A, are the steam cylinders on one side of the ship. A' A', are those on the opposite side. B B, B' B', and C C, C' C', are respectively the corresponding pistons and piston-rods, the latter of which carry the cross-pieces D D. Attached respectively to the cross-pieces D D, are the ends of the connecting-rods E E, the other ends of which are pinned to the crank-arms F F, on the shaft G. H H', 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' A', K K', are the air-pump rods, of which K is directly attached to one of the pistons B B, and K' to one of the pistons B' B'. The slide-rods L L, are worked by the arms M M, attached to the axles N N, which have a rocking motion communicated to them by the link motions by means of the rods O O', and the arms P P'.

The remaining parts of the engines will be readily distinguishable, and the arrangement of them understood from the remarks we have already made.

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). It 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 commuters would be subjected in the readjustment 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.

It was 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 the public had 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 confidence.

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 means of standard.

First. The standard of fineness depended on the quantity of alloy introduced in the process of manufacture, or coinage. If this was identical in all countries, great trouble would be avoided, but it was argued that practically such a standard 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 coin 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 was about 21s. 6d. English, and the half-eagle—11s. 6d. 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 24 per cent. now existing, and this would involve the readjustment of the whole currency. It was said that the "franc" was 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 "franc" would only be a reduction of the new coin to the exact value of a French franc, which equalled 9½, and so on for the rest of the proposed series, thus showing a real difference of 4½ 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 was the nominal pound the real pound.

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 relation of the gold to silver 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; if so, 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 was now admitted to represent the value of the quantity of gold contained in the pound,—all the silver 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 in transactions of the relative value to which they were assigned, and that integer should not be less than the pound sterling. Wages were calculated in shillings by the artisan,—he knew that twenty of these shillings equalled a pound, and the subdivision of the shilling was of little consequence to him. Provided, at the least, the smallest 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 were 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 values.

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 admitted, 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 miles = 1 penny.
- 10 pennies = 1 shilling.
- 10 shillings = 1 guadon.

This, like most of the other schemes for adopting a new nomenclature did not prove popular.

It was contended, that the present was an appropriate moment for the adoption of a standard; that there was a 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 Maurry'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 adopt the monetary system of this country to that of any other must be productive of confusion, and lead to the destruction of 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 10d. 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 of 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 testing of the broad shield of William the Conqueror, which had long been descriptive 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 silver and gold, and in all cases the adoption of a new nomenclature was specially objected to.

The system proposed by General Sir C. W. Feailey 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 commercial transactions. After reviewing the arguments of the previous speakers, it was contended that the opposition to the author's views was untenable, as the benefit derived from the introduction of a decimal system was admitted, and it was only urged against it that it would be unacceptable to get all countries to agree. Now, if England and her colonies adopted the system, already accepted in France, and which had made great progress in the other continental countries, there would be so large a preponderance in commercial transactions, that other nations 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 coining was 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, whose convention meant a 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 the national and all the other independent States. The coinage was generally taken by the banks. How much simpler would it have to be taken one decimal system for all. If that were done in the case of England, France, and other pieces, fixing the British stam,
It was contended, that for all practical purposes of commerce, 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 sovereign continued in use, though it 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 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 sufficiently accurate for practical purposes. Besides which, he contended that if the velocity of the vessel was 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 state of science, the quantity of water issuing from the nozzle 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 in raising the water to the velocity of the vessel | 141 |
| 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-waves and of the engine itself | 34 |

The absence of indicator diagrams was regretted, as tending to throw a doubt on the results. 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 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 constrictions of the fluid by sudden enlargements or alterations in its course. The desired object was stated to be to proportion the dimensions of the engine and the propeller, so that the efficient 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 engine, it was stated, would be very cheap and action very safe. Mr. Stephenson, the Engineer of the Fire Brigade, had carried the plan out, and, in fact, it had 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 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 statement in the paper on Rutherfurd's propeller had been misunderstood; as it had been assumed that the useful effect realised was 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 absolute pressure at the nozzle was 64 per cent. of the power developed in the piston, 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 efficient velocity of the water exceeded the receding speed of the vessel, and diminished as the receding speed of the vessel, and vanished only when the vessel had acquired the efficient velocity of the water,—when the simple pressure due to the head of water remained. Therefore, that some allowance should be made for this duplicate pressure; and that 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 efficient water, leaving 38 per cent. of excess.
The first Paper read was "On the Prevention of Smoke in Engine and other Furnaces." By James Simon, 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 noted with apprehensive even, as early as the time of Charles II, 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 re-consideration of this question of smoke abatement was re-visited on the subject in the sessions of 1819 and 20, and again in 1848, when a very complete history of the subject was given in the report, with a clear recital of the scientific evidence, recommending a freer admission of air to the fire, and the use of "smoke boxes," not the "smoking 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 1855, the "Smoke Nuisance Abatement Act." This Act rendered it compulsory on owners of engines and furnaces, to provide means for preventing the emission of opaque smoke, if it was used in 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 as desirable an end, and the desirable furnaces 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 pollution of the atmosphere. The smoke of opaque furnaces was considered, and from the analyses 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, with an air com- bination, when 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 fire, 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, 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. W. Williams, Assoc. Inst. C.E.
producing, on the instant, the largest area of surface for mutual and almost instantaneous absorption and practical extinguishment, and, further, that 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.

In the result of the same experiments, it was discovered that 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 of the mixture of the air and the gas before the carbon lost its heat, and the escape of the flue gases below the point where the air was admitted, or kindling. This, according to Sir Humphry Davy, should not be under 800⁰ F., as ignition could not take place at a lower temperature—that fact being the principle of safety in the miner’s lamp.

In conclusion, it should be stated that 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 the furnace, and the same depth of flue as the horizontal, was, however, determined as 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 experiments, led to placing the orifices of admission in the front, or at the door-way end of the furnace. The system adopted by boiler-makers, of contracting the doorways of marine boilers, much improved a subject hitherto neglected. It was equal to 8 to 10 inches of air sufficient for the required number of 3 or 4 inch orifices. By this arrangement, the length of the furnace, from the door to the bridge, was equal to the length of the run. By this improvement and on the Argand 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 or gas of the area of admission 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 1/4 square inch for each square foot of fire surface in the form of a single furnace; and of but half a square inch or 5-inch for each square foot of grate-bar surface in the case of double-furnace boilers. These proportions were now asserted to be wholly insufficient, and in fact were not sufficient to allow of one-fourth of the area of air, in practice, as was ascertained that for bituminous coal, 4 to 5 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, that the fires should be kept well alight and uniformly covered; for if the height of the sides of a furnace were left uncover, the air would pass through them, instead of passing through the air-distributors, as that passage offered the hottest part of the furnace. The practice of the places was, therefore, that 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 such valves had been tried during the last ten years, but had all 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 inexplicability of such valves, and furnished the only reliable test, as to the quantity of heat produced and proportioned to the gases entering the furnace.

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 engines leading to the different places. 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 action. This division emphasized the several constituents of gas and air—the former being hydrogen and carbon; the latter, oxygen and nitrogen; the relative volume of each was given, and it was shown that ten volumes of air were absolutely required to the one volume of air, or one hundred of total gases. The third 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 light required for the oxy-hydrogen mixture. The exposure to the piece of lime, carbon, or other absorbent 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 burned with a much slower flame, the same result (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 carburetting of the fuel, 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 necessary quantity of air, in practice, 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 problem 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 ever been attained. Thus, a supposing a furnace to be 4 feet by 5 feet in section, and the furnace grate to be 20 square feet, the combustion of 2 cwt. of coal per hour, and for the gas alone, a supply of 10,000 cubic feet per hour, or, or 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:

<table>
<thead>
<tr>
<th>Air aperture</th>
<th>Velocity of draught</th>
<th>Quantity of air</th>
<th>Quantity for per cwt. coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 sq. inches</td>
<td>5 ft. per sec.</td>
<td>7,500 cub. ft.</td>
<td>75,000</td>
</tr>
<tr>
<td>3 sq. inches</td>
<td>10 ft. per sec.</td>
<td>15,000 cub. ft.</td>
<td>150,000</td>
</tr>
</tbody>
</table>

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 of the necessary quantity. By close observation, by means of an anemometer, 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 6 feet per second if the draught was poor.

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. Wyse 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 than one-third of the gases carried with the stokes of air, 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 separated the body, or even in the form of a film, the gases were brought into the furnace, 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, insomuch 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 re-built after destruction, but the large majority caused additional impurity in the atmosphere. From 1845 to 1853, the whole number of houses with chimneys of more than 16 feet 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.

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 which that was in itself a simple question. All that the public cared about was, how to prevent the smoke coming out of the chimneys; and how to prevent the same from being raised to a lower temperature, or by others arranged like Venetian blinds. Practically, the end could be attained by the mechanical systems of Juches, Hasell-Hull, and others, or by the double-furnace boilers of Galloway, Rose, McAlpine, and others, or by the systems of Williams, Frideaux, 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 were some space boiler, with a grate that the requisite was it's only recommendation, as it could not improve the draft, 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 proposed by Mr. Prideaux, the well-known practical system of Prag and, that of what we are able to secure, 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's argand furnace.) -3. The keeping of the outer surface of the furnace-door comparatively cool, and thereby both economizing heat and preventing its radiating 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 air through the grates, as in the usual manner, had been generally preferred. The system of alternate firing, and of having ample boiler space and good draught, was insisted upon.

This was carried on, of behalf of the Manchester methods of firing, that at Price's canal factory, at Vauxhall, three methods, Juckes's, Hazelden's, and Hall's, were employed with success. The general principle, of a continuous supply of fire 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 disarrangement. These, however, were now diminished, particularly with those of Juckes and Hazelden, 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, illustrative of the necessity of admitting the air above the indescending 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, the smoke from one being led into the apparatus of Juckes, and that from the other into that of Hazelden, 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.

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, skillful firemen must be employed, and that it was desirable that the subject should be directed of all complexity, and should be rendered cheaper. The most advantageous employment of mechanical methods of stoking, particularly at the brewery of Messrs. Truman, Hanbury, and Co., where sixteen sets of Juckes's apparatus had been used for several years, and had induced a great saving of fuel, as also 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 altered defects of those systems were shown not to exist in the apparatus of Juckes, Hazelden, 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 thus obtained from so intense a combustion would extend to the fire-bars. The success attendant on Mr. Houldsworth's system for preventing smoke, and on his invention of the metal rod pyrometer, were described.

The general result of the investigation appeared to be, that although for certain establishments the mechanical methods of firing were successful, it could not be expected they would be adopted for every furnace in the country. The system, in so far as the manufacture, therefore, a good system of mingling a due proportion of atmospheric, and of atmospheric, and of combustion, was essential, and the method employed by Williams appeared to fulfill 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 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 the view. The distance is not far, 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. These, however, who have examined the structures of ancient times at once perceive the artistic perfection of these works.

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 covered 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 twelve inches in width. The flags are neatly chiselled 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 grandly-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 beautiful engravings, in Wild's 'Beauty 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 eggs and cavities, 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 chambers; 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, Mr. Williams compares to this case, the three mounds being the great pyramid in the largest pyramid of the Sakkara range, which 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, according to the older writers, the lotus, or lily, was represented most accurately in relief.
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, to make the offices go with it, and form a consistent portion of the whole, in an artistic and effective manner. The principal additions are—The main building, a new oriel 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 oriel, 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 no slight 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 principal door and a half stone steps, which 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 thoroughly 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 vase. 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 visible 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, since its front has been improved, and were 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 spandrels, 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 and 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. Neafield, 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 house.

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 Victory. 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 ACCESORIES 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 10th.]

The great evils connected with the common coal fires are—

1. Production of Smoke. 2. Waste of Fuel. 3. Defective Ventilation and 4. Staining 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 the cause 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 pounds in 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 increases of smoke. A growing flower, if exposed to the atmosphere, is always covered with black 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; and more are progressively brought from the country from the city, are soon found 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 and world-wide extent 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 peril 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° Fahr., 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 carbon and hydrogen, such as we call gases.

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, with 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 by introducing an ingenious machine known as the 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. The apparatus, like the burning red-hot coal, 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 slats in the side of the coal-box, and was lifted by chains at each end, drawn up by a windlass, and this windlass by bevel 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.

The fire-box 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, fig. 1. A screw, turned upwards, is used to turn 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 nothing 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, will happen with kitchen fires, to replenish the coal-box in the course of the day, it can be done almost as easily as when the fire is 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 bottom to the coal-box. So soon as the piston box is being then allowed to come 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 under joined street 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 unburnt products of combustion thus pass from the fire, and on account of theunger that the coal has been having 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 lighted, like a smouldering fire from the bottom upwards, until nearly the whole contents of the box are consumed, and then 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 blowing out the few lamps of coke or coked 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 combated.

II.—Waste of Fuel.

We now come to consider whether the waste of fuel which occurs in common open fires can be prevented.

Mr. Rundell, 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 chiming-room, has maintained, day and night, from October to May, a temperature of 60° or more, and it does so with the best good ventilation, by an expenditure of only 12 lbs. of coal for 24 hours, or about a fourth of what would be used in an open fire burning for 15 or 18 hours. This fire is lighted about the beginning of October, and is not extinguished until the following winter, by which time all the air is fresh and free from any combustible that escapes from it when the fire is burning briskly; and reflects further that such columns consist entirely of the warmest air from the room, blackened by a little pitchy vapor from the fire, there is protection to the pictures, 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. The smoke and wood, and combustible burned in a room. Now, the true smoke of a common fire is not the whole of what is seen issued from the chimney top, but only little droplets 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 smoke of a pipe, and it is only what is carried in the air around 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 without, and persons suffering from 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 readily from it with 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 barracks or lodging-house for persons engaged in the working of the mills and had nearly 500 inmates. Like all factories 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 my 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 opening 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 for the reception of all the fresh, cold 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 $e$, 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 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 appearance, 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 configurations 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 white 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 lessening 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 flame 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 hydrogwn 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 necessities 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 $r$ or chimney piece, two jams, and a common grate with two bars and bottom, to which four parts, the essentials of the new fire-place, are added. $s f g h$, 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 $g$, it has also a moveable bottom $s$, 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 $p$, which, acting as a lever, having its fulcrum in the foot of the box or otherwise, lifts the piston. A catch or pull $k$, 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
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. Moirata), 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 suggestions to improve the present 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 satisfactory result.

Mr. Garling said, that he was much gratified to learn that Mr. Boulnois had 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 unsatisfactory for the metropolitan 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 18-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 stoppage, 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 the sewers. Reference to this pipe sewer, Mr. Garling afterwards, in order to aid its current, it was laid with a fall of 14-inch in 10 feet, or equal to 56 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 1 mile long) and with a water bed 18 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 danger of sustaining 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 4-inch soldered soil and rain-water pipe, being choked up for some months, notwithstanding there was a head of water standing 4 feet over the pipe, and with the drain head-valve a 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 admission in 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 drain, the water would be 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 admission of the air to the water pipe, and therefore an air vent, 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 week 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 Marylebone, where the flat level has been raised, but also 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 exposed to discussion and attention, in opposition to 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 running from one house under the others—in which case the basement at the lowest level might be flooded from 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 Graves; that on the North side of the river there should be a main sewer—say from the Dock to Graves end; that on the South side 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 Graves 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. A general rule he scarcely knew a small drain that did not choke up, nor a large one that did. Mr. Harwood, C.E., with reference first to the question of means, stated that there was not a thorough 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 much with many of the other, the water would be drawn 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 advantages and it was almost as important that a house should be dry, as that it should be free from all the inconvenience. 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 a new theory could not be tested for all it was so, as its theory was the expedient against the objection. They were, 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 structure. The use of the sewer would be more easily 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 storage 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£ to 30,000£ a year. He had now a great number of sewers which had not been opened for years, and some of which were never used. 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 preventable stoppages, but where stoppages occurred repeatedly from similar causes they could not be called preventable, but rather constant and preventable stoppages, and those which were in the fat-bottomed state of the sewer was subjected 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-cleansing. The pipe, however, was stopped from end to end, and he could not tell the cause of it, nor whether that cause was preventable 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 deposit is superimposed on a harder one, which impeded everything passing through it. If he might be permitted to allude to published books, he would refer to a blue-book containing 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 theorizing on this subject, if it proved anything, it 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 triple the area required, he (Mr. Haywood) would only reply that, even in such cases their own witnesses 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 previous statement, the reduction of sewers was necessarily, and the reduction 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 air through the houses, a most desirable object; and, 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 chimneys, it appeared in certain conditions of the atmosphere that the effluvium was driven rather than carried off. He believed that it would be better to ventilate in the centre of the street or by the people's 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 of all kinds clean their houses 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 fiscal 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 manures, which had brought their price down to a fraction of what it was, 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 them with the least possible care; the drain of the Palatine 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 water-closets 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 communication 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 is often the case, particularly in flood-storms, there being 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, with certain well-known limits, would allow of such undulations as the interfering surface might require. Thus a reservoir at Piccadilly might have its reception-pipe carried below the level of St. James's-park and the western 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. Interseeping 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. Newbery, in a paper read before the Society of Civil Engineers, gave an accurate 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. The number of houses laid in streets," whereas the total number of houses drained within the last four years amounted to 28,978, of which 4926 were drained in 1890; 8561 in 1891; 6271 in 1892; and 7380 in 1893. Of this number, 20,000 (instead of 7300, as stated in the Builder) were drained with 6-inch pipes. Mr. Bazinette, in his paper, stated that for a bridge of 620 feet long, 3 inches was ungenerously 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 led, upon the appearance of 4-inch and down 6-inch pipes, although they did not feel justified in spending the public money in that way, it was being done to a greater extent by private individuals. In the same manner, the quantity of pipe sewers (“upwards of 500 miles”) have been greatly overstated in the article referred to. They had been quoting figures of 62 miles of brick sewers in the year 1858 and 6 miles of pipe sewers, whilst private individuals had executed about 13 miles of brick sewers, and about 65 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 prove in any way whether if the proposed pipe sewers were 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 system for the purpose of the streets and the best, and a system of drainage which might be the 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 door of a house, and then carried in a state of health by workmen, and certainly pipe sewers in the same situations would allow deposit to be made in a different 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 subsequently showed, from 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 superficial resistance of water to the scouring power in the former, when three-fourths 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 brick sewer for the great amount of erasing that was in existence in the sewerage, 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 Commissioners of Sewers in our metropolis had from 1850 to the end of 1854 a total of 35 miles of cesspools and channels, and half a mile of main drains. 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 supervision was exercised in their construction, and excised, the cost in the outlay of time and expense (hydraulic time), 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 deep discharge" were used; and Mr. Boulnois 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 "that the gallons of water per drain should be allowed as a proper supply to each house, but at Croydon 300 to 500 gallons had been given to each house to carry out the cleaning of these — so called — self-cleansing small tubular drains. Amongst the objections to back drainage one had been overlooked, namely, that the land from which it was collected 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 obtained 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 all alarm.

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. Imman suggested that the answer would be given by Mr. Bazalgette in 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 as which the pipes were laid, and the nature of the soil. He had seen pipes which were broken by disuse, 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.B., E.I. said, that in his own country in Paris were not trapped, and that a vast quantity of fiscal matter passed into the sewers, notwithstanding the Municipal prohibition.

Mr. Burnell stated, that according to the experiments of M. Bossingsgout, 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 133 feet long and 12 inches in diameter, with a fall of 1 in 120; eight houses drained into it, and these were filled with watercress and cyphon pans. It was stopped up from end to end, and he was informed it was caused, 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 case when the Board of Health attempted to employ 2-feet pipes for this purpose. 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 having more than one 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 afterwards 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 14 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 the bricks from building as a pavement. 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 interpreted 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 would be very useful to them to have more stoppages than had actually occurred. He attributed these 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, any accident of this kind 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 be blamed if they did not stipulate for a proper amount of strength. As soon as the rage for cheapness which existed a year or a half ago had subsided, he had no doubt 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. If its thickness were increased to 13 inch or 14 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 precision 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 surfait, or ultimate disposal of the sewage matter, presented a question which appeared by intermission and of course 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 country, the sediment in the 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 was also being emptied. Mr. Bazalgette's theory as to the surging power would not apply when a deposit had been formed; and the cleansing he had referred to absorbed the whole local sewer rate of 6d. in the pound, with all the expense of removing the grime, &c, leaving nothing was useless 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 reverse would not be the case, the means for preventing the same from occurring 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. He was satisfied these increased prices 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 case when the Board of Health attempted to employ 2-feet pipes for this purpose. 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 having more than one 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 afterwards it was acknowledged, that though a 9-inch pipe might be sufficient, a 12-inch pipe

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 and on different sides of the river, and through which 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 northward, and although the main was not the most direct 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, was lower than it. The consequence was, that the Board, after several years' delay, spent a considerable sum to lower a 3 ft. 6 in. sewer, into which he had to drain his 4 ft. 6 in. sewer (the site insisted on) through an intermediate 1 ft. 6 in. barrel drain. When the reign of this body had come to an end, a portion of the arrangement was out 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 the houses for the Commissioners, and pass through the square, as well 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 9-inch barrel sewer. Generally speaking, a 9-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 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. Isman 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; he described the system by which water from the well of Welsey, 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.

LEWIS WELLAM, Pateaue, July 2, 1853
(With Engravings, Plate XXXI.)

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 civilization.

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 and forms of all the mountain systems of its surface, and 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 mixture of water, heat, electricity, and of the great energies of nature.

Chemistry is employed to recognize, by analysis or decomposition, what elements enter into the formation of a compound body; to determine, by synthesis or reconstruction, what bodies will result from particular combinations; to describe the peculiar properties of each element or of each combination of elements. That the 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 producing the least injury to others, and with great economy in working, 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, and submit the result of the chemical 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, were not machinery—tools—machines—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 chemist or machinist, who, also struck with its novelty without being able to inquire into its practical application, regards it as if it were a similar manufacture (an Indian who has seen something novel), and calls on the world to patronize 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 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 it. 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 is capable of reducing horizontal basalt. It 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 3 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 which it is joined at its bottom, working into another bevelled wheel connected with the prime mover, a great many serious practical objections must 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 samander, and the ball or balls will wear the inside of the basin into an irregular churning groove.

From the preceding observations, and an attentive consideration of the bearings connected with the important application of practical machinery to the wants of the miner, we have great pleasure in submitting for public approval and support, the revolving metal washery by Mr. Wright and Mr. Watney. 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. Amalgamating by quicksilver, and the application of steam to inside of machinery, 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 c, revolving on the same shaft as a heavy fly-wheel. Around the central cylinder are five smaller iron cylinders d1, d2, d3, the shafts of which rest in adjusting blocks supported on projecting brackets of framework, provided with adjusting screws 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 plumber-blocks a, connected to iron framing. The two iron cheeks or frames e, e, are connected together by iron ties-rods. The machine is fed from the top 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 bevel 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 l, l, weighing about five tons each, having solid peripheral connections 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 upon 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 bevel-wheels 4, 4, 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 bevel wheels, vertical shaft, the disc-plate, and iron rollers by contact, causing them to revolve in their frame places. The quartz is continually under the rollers until it is reduced to an impalpable mass.

III. MIXING, WASHING, AND SEPARATING MACHINERY.

The impalpable powder is put into the Mixing machine, which consists of a narrow, rectangular wooden vessel m, in which revolves an iron wheel s, 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 agitation, and then flows down a trough q, connected with the top of 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, which is connected to a vertical iron shaft r, driven by two bevel wheels a, s, in connection with the prime mover. At the bottom of the cylinder is an eductor f, 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 bevel 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 forces 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 central 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 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 passes off from the horizontal 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 bevel 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 passes 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 received, 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, having the effects 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 efficiency of the washing and separating process.
4. The washing and separating processes 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. High-pressure steam applied to the inside of 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 metallic 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 1,636,950$, of which 886,410$ is in advance on account of future calls. The increased amount of foreign line, 25,193$, 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 382 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, Montreal, Grand Trunk, and Stratford, so that the line shall be opened from Montreal to Prescott, between Montreal 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 1836. 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,—Abeance from England, and other unexpected circumstances, have prevented me 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 a fixed pier and 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 may not properly be looked upon as permanent, substantial, and safe structure. Its flexibility, I was informed, was truly alarming, and although another structure of this kind is in progress 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 trusting 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 appearance appear to be a saving of time and expense, they will prove 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 thereof much exceeds that of the Menai, the difficulties which surrounded its erection will be involved in the present instance. In the Britannia, the two larger openings were each 490 feet, whereas in the proposed Victoria there is only one large opening of 350 feet, all the rest being 240 feet. In the construction of the latter, there is no 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 features, 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 impossible of adoption. The first object was the establishment of a special and, I believe, the first of its kind in this country, which has, I am happy to say, been accomplished.

On my arrival in Canada, I found that Mr. A. M. Ross had collected so much information bearing on the subject of the bridge that my task was comparatively an easy one. Amongst the intelligence of the two municipalities of Montreal and Quebec, that 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 further below down the Island of Quebec, the channel 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 such bridges. I was shown several 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 phenomenon of the breaking up 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 the force is simply the impatience of the masses occurring on 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 increased by the pressure applied to the sides of the river by the floating of the ice, and partially 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 we come to reduce the same power of a tube so as to obtain a sufficiently safe result is arrived at. In thus treating the subject of the forces that may be occasionally applied to the pier of the proposed bridge, I am fully alive to the many other cir-

circumstances 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 shores, 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£ upon one line 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 inadequately 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 system 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, St. George-street, Westminster,
May 2nd, 1854."

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 joints, 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 joints in section; fig. 2 is a view showing the girders in section; figs. 3 and 4 are sections of the columns, and fig. 5 a section of the floor on a larger scale; and fig. 6 a sectional view 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 3½-inch flanges, D, 4 foot braces, and 10 inch 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 seysal asphalt floor.

The floors and roof are approached by a spiral staircase of cut stone, in a lower exterior to the rear wall of the warehouse. The building is occupied as a flour, 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 30 feet below the surface, under which is a stratum of water. The foundation is to an outcropping, of 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 25 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 air-vaulted brickwork, set in hydraulic mortar. On this is laid a course of sandstone, 3 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, &c. also the cornices, copings, stringcourses, window-ills, &c. The stone was procured from the Kilmuir Quarries, near Glasgow. The rest of the walls are built of Beart’s perforated bricks.

The seysal flooring and roof was laid by the Metropolitan Mineral Rock Asphalt Company, and the joists and girders were rolled at the Bedford Iron Works.

RAIN AT DIFFERENT ELEVATIONS.

By THOMAS HOPKINS, M.B.M.S.

There has been, during the year, a large quantity of rain, both at low and high elevations, for which reason it may be assumed as certain 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 atmosphere, the drops of rain are thrown off latitudinally 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 water, the cold of the rain would condense upon the drops some of the vapor, when each drop would be enlarged in its descent. These drops, 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 be smaller as it descends, and the whole of the air within and beneath the cloud may, according to the degree of saturation of the part of the atmosphere below the cloud, be evaporated so completely as to cause the cloud, which 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 cloud will not receive the whole rain that is formed directly over it,—but only that wind conducts to it, the wind conduct corresponding to the wind,—and in hilly countries it may, and indeed does commonly fall against the rising ground. The higher ground thus fre-
The Civil Engineer and Architect's Journal.

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 stratus cloud on level ground or on 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 lower levels with a certain force, and by friction creates friction, which regards the advance of the higher part of the air, and, LIKE redistribution 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 friction 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 the Yorkshire, would be 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 quantities of rain which fall on or 30 inches from the western edge, 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 owing to the irregularities of the ground, and even to the trees and buildings, which produce 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 rising land having 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 continuance 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 warmed from Yorkshire, or 30 miles, or 50 miles, or 40 miles, the dew point is at 52°; that has already stated, the vapour constitutes about one forty-eight part of the whole, whilst with a dew-point of only 32°, the vapour is only one two hundred and forty-part of the atmosphere. Now if from any cause air with a dew-point of 60° should be brought up to a height above 32°, 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 45th part of the atmosphere, converted into water to fall as rain. And therefore, that 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 aëroform 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 it is supposed to descend as fast as the air ascends, it is obvious that the rain would commence, 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 heated, heat is liberated and an ascending current is produced, and we do not know what will be the quantities and descending 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 atmospheres.

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 Ben Nevis, to a height of 8000 feet, it would be like the temperature of 45°, while the dew-point would be the same. 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 to a height of 8000 feet in Norway, would require 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 at the surface and 32° at the height of 7500 feet, would be condensed, and might fall as rain. Now the atmosphere of 53°, 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 940th 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 we may conclude that the more the temperature of an atmosphere 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 15, 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 difference of 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 falls of rain at Windermere, and at a certain distance from that, and 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 then decrease. He points out, with a probability that in mountainous districts the amount of rain increases from the valley upwards to an altitude of about 3000 feet, where it reaches a maximum, and that above that elevation it rapidly decreases. Now, although the facts thus given are important, the hypothesis is only a part of the 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 to 1849; 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 seacoast, the second on the summit 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:

<table>
<thead>
<tr>
<th>Year</th>
<th>Whitehaven</th>
<th>Wastdale-head</th>
<th>Seathwaite</th>
</tr>
</thead>
<tbody>
<tr>
<td>1845</td>
<td>90 inches</td>
<td>106 inches</td>
<td>90 inches</td>
</tr>
<tr>
<td>1846</td>
<td>90 inches</td>
<td>106 inches</td>
<td>90 inches</td>
</tr>
<tr>
<td>1847</td>
<td>90 inches</td>
<td>106 inches</td>
<td>90 inches</td>
</tr>
<tr>
<td>1848</td>
<td>90 inches</td>
<td>106 inches</td>
<td>90 inches</td>
</tr>
</tbody>
</table>

Mean: 90 inches

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 these places, there is the Pass or Saddle, 1290 feet high, situated between Wastdale-head and Seathwaite, on which a rain-gauge was placed; it is, however, so cold 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 part of the year. Yet we may compare the quantities of rain that fell in the summer months only at Wastdale-head and Seathwaite, as given by Mr. Miller—they are for the six summer months of 1848—(see page 215).

Seathwaite, 240 feet above the surface of the sea; Sty-head, 1290 feet above the surface of the sea.

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, 1030 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 fell at various heights, including great elevations, it is obvious 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 1845 and 1847 in six places, namely:

<table>
<thead>
<tr>
<th>Place</th>
<th>Rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Valley</td>
<td>160 feet</td>
</tr>
<tr>
<td>Sty-head</td>
<td>1290</td>
</tr>
<tr>
<td>Seatoller</td>
<td>1344</td>
</tr>
<tr>
<td>Sparkling Tarn</td>
<td>1900</td>
</tr>
<tr>
<td>Great Gable</td>
<td>2925</td>
</tr>
<tr>
<td>Saw-fell</td>
<td>3166</td>
</tr>
</tbody>
</table>

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 1705 inches; whilst Seatoller, 1344 feet high, and consequently 1184 feet higher than the Valley, has only 1565 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 Brunt Riggs, 500 feet high, between the Valley and Sty-head, which received 156 inches 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, 1290 feet high, in the summer months received 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."
The 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. In several languages it is 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 it. When, however, the fall of rain is determined by 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 the cliff, the height was not sufficient for condensation of 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 placed 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 gauges at the lower part of the vale. We are therefore to 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 lapse of heating to the aqueous vapour that is contained in our mixed atmosphere, whilst the vapour is diffused through the gases.

The following account has been furnished to me of the fall of rain in a year at Cushulind Lodge, in the Isle of Skye, being the mean of the two years from Sept. 1, 1849, to Sept. 1, 1851.

<table>
<thead>
<tr>
<th>Month</th>
<th>Daily Rain in inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>0.15</td>
</tr>
<tr>
<td>February</td>
<td>0.12</td>
</tr>
<tr>
<td>March</td>
<td>0.09</td>
</tr>
<tr>
<td>April</td>
<td>0.15</td>
</tr>
<tr>
<td>May</td>
<td>0.10</td>
</tr>
<tr>
<td>June</td>
<td>0.12</td>
</tr>
<tr>
<td>Total for the Year</td>
<td>0.70</td>
</tr>
</tbody>
</table>

GAS METERS.*

Moseh Poole, Patents, August 8, 1853.

This invention consists of an apparatus for regulating the supply of gas or other aériorum 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 close the either end 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 aériorum 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 bottom of which is 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 aériorum fluid to, when it passes away at the outlet K. The gas or other aériorum 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 aériorum 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 aériorum fluid in the chamber H, is more or less an excess of the pressure that it is desired the gas or aériorum 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, as would be the case with our feet as we proceed up or down hills.

Claim.—The combination of two or more governors or regulators so that they may come into action in succession.

* Reported in the 'Repository of Patent Inventions.'
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 consider the economy of fuel and the produce 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, and 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 1 1/2 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 contribute to the advancement 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 coke 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 fitted in part, and 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 beenworking since August 1853, and run 13,600 miles between Southampton and London, a distance of 758 miles, taking the regular running of passenger trains; the average consumption has been 17 5/8 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. Another experimental trip was made by Mr. W. F. 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 to the official returns.

Experiments with the 'Britannia' Engine and Passenger Trains from London to Southampton and back.

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of double trip with train = miles.</td>
<td>15 1/4</td>
</tr>
<tr>
<td>Length of double trip with engine = miles.</td>
<td>18 1/2</td>
</tr>
<tr>
<td>Down trip, average</td>
<td>12 3/4</td>
</tr>
<tr>
<td>Down trip, average speed running, miles per hour.</td>
<td>31 1/2</td>
</tr>
<tr>
<td>Down trip, number of stoppages.</td>
<td>2</td>
</tr>
<tr>
<td>Up trip, average</td>
<td>19 3/4</td>
</tr>
<tr>
<td>Up trip, average speed running, miles per hour.</td>
<td>22 1/2</td>
</tr>
<tr>
<td>Up trip, number of stoppages.</td>
<td>7</td>
</tr>
<tr>
<td>Total consumption of coke, cwt.</td>
<td>18</td>
</tr>
<tr>
<td>Total consumption of coal,</td>
<td>4</td>
</tr>
<tr>
<td>per mile of train, lb. per mile.</td>
<td>16 1/2</td>
</tr>
<tr>
<td>Total consumption of engine, lb. per mile.</td>
<td>20</td>
</tr>
<tr>
<td>Water evaporated, lb. per mile.</td>
<td>8</td>
</tr>
<tr>
<td>Average pressure of steam, psi.</td>
<td>100</td>
</tr>
<tr>
<td>Average pressure of steam, up trip.</td>
<td>100</td>
</tr>
<tr>
<td>Greatest pressure, up trip, lb. per mile.</td>
<td>13 1/2</td>
</tr>
<tr>
<td>Least pressure during trips (omitting last ten miles).</td>
<td>60</td>
</tr>
<tr>
<td>Average pressure in miles stated, lb. per mile.</td>
<td>82</td>
</tr>
</tbody>
</table>

The action of the coal and coke fire-boxes is as follows:—The coal fire-box A A, figs. 1 and 3, 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 space of which is occupied with the back of the coke fire-box by two branch pipes C C, at bottom, and two at top. The coke and combustible gases thrown off the coke 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 forming a sort of fire-tube is placed within the coke fire-box, fronting the tubes leading from the coke 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 lids, whereby the ashes are trapped, and the results are as follows: the smoke 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 affected, the smoke being excited to the utmost, and 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 76 1/2 miles, thus preventing the frequent admission of cold air to the fire-box and tending, as a necessary result, to a liability to leaking in the present state, and to alternating at the coke 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 to 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 traveling was a consequence of the cold-water system of working, and when working was found to be such that when an engine was heated exhausted, 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 power of the engine, and compelling the engine to work below her utmost capability. This evil being so great, the author attentively reviewed the whole system of the engine, with a view to improvement as well as economy; seeing that nearly the whole of the calorific which had cost so much was finally dissipated as useless at the chimney, it occurred to him that part of such calorific might be intercepted and communicated to the cold water used for supplying the boiler, and 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 as the smoke-box, and into which was inserted a small 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. The upper pipe L L, in connection with that of the chamber communicates with an outer condensing apparatus fixed in front of the chimney, consisting of three upright pipes K K L 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 injectors supplied with that of the condenser, which draws its supply direct from the tender. There is thus 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 P P, 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.
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 send it into the blast.

The construction 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 cold water 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, where many long and steep gradients exist particularly that between Bishopsstock and Beasington, the gradient averaging 1 in 230 for 17 miles; the Southampton, Portsmouth, Gosport, and Sallisbury trains, being all joined at Beasington, and taken in one train to London, which generally contains from 20 to 25 cars; 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 the 100-ton train running 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 156 pounds per mile, the 'Britannia' having run 13,000 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 of the steam to the orifice of expansion, 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. HENWORTH, 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 or by means of more frequent contact. 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 motion by means of teeth, it is essential that the nature 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 gearing should be constructed of grooves 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 face; consequently, in an isosceles wedge with rectangular faces, if $r$ represent the angle at the vertex, $P$ the pressure at the head, $P$ the pressure at one of its faces, we have

$$P = \frac{2}{r} \sin \frac{r}{2};$$

$$P = \frac{2}{r} \cos \frac{r}{2}.$$

Therefore, by diminishing the angle at the vertex we have a means of indefinitely augmenting the pressure of 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 action of various wedges with grooves of different angles and lengths in driving screws 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 $30^\circ$, moving in a cast-iron groove with the pressure or weight $5$ produced the resistance $872$, representing the same substance with an angle of $20^\circ$, and carrying the same weight, produced the resistance $506$. Another wedge with an angle of $10^\circ$, and in all other respects similar to the last, produced the resistance $93$. A wedge of brass, shaped as the last, and carrying the same weight, produced the resistance $1080$.

These experiments fully confirm the principle on which the wedge is to be applied in machinery. The nature of the new system of gearing 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 two vertices of contact, is equivalent to a pressure 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.

<table>
<thead>
<tr>
<th>Conditions of Experiment</th>
<th>Pressure of one wheel at the Friction or at the Adhesion of the Wedge</th>
<th>Ratio of the Friction or Adhesion to the Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle of $30^\circ$, iron on iron—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Both wheels large</td>
<td>14485</td>
<td>0.0287</td>
</tr>
<tr>
<td>Small grooved wheel</td>
<td>12254</td>
<td>0.0300</td>
</tr>
<tr>
<td>Large wedge wheel</td>
<td>47514</td>
<td>0.220</td>
</tr>
<tr>
<td>Ditto</td>
<td>47527</td>
<td>0.245</td>
</tr>
<tr>
<td>Small wedge wheel with</td>
<td>96227</td>
<td>0.0174</td>
</tr>
<tr>
<td>Large grooved wheel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ditto</td>
<td>96227</td>
<td>0.0174</td>
</tr>
<tr>
<td>Angle of $20^\circ$, iron on iron—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Both wheels large</td>
<td>20360</td>
<td>0.0140</td>
</tr>
<tr>
<td>Both wheels small</td>
<td>40000</td>
<td>0.0292</td>
</tr>
<tr>
<td>Small wedge wheel with</td>
<td>84290</td>
<td>0.0185</td>
</tr>
<tr>
<td>Large grooved wheel</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* From the "Journal of Industrial Progress," No. 4.
† M. Minotto first published this discovery to the Academy of Science in 1859. He considered it an important one, and the subject of a short and very valuable lecture delivered at the Paris Engineering School.
with small wheels than with large, and that it slightly diminishes in proportion to the increase of speed. It does, however, remain 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 45°, 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 under- went no change by varying the wedge angle so as to obtain the result which does not seem to have been noticed by M. Minotto himself. To compare the friction produced by the proposed method of gearing with that of ordinary toothed wheels, M. Minotto has used the expression:

\[ f = \frac{1 + \frac{1}{m}}{m} \]

\( f \) being the coefficient of friction for the substance composing the teeth; \( R \) the force exercised by the wheels on each other; \( v \) the ratio of the diameter to the circumference; 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 of 100 lb.; for an angle of 54°, and consequently the friction of the teeth is 21.42 lb. Two wheels on the wedge system, having to transmit the same force, would undergo an amount of friction measured by 9081 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 gearing 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 is not the case with the teeth of the ordinary system—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 grooves 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 trouble 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. Pouillet 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 ordinary wheels, placed on the web of 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 rotary motion to the great axles of screw steam-ships, the screws of which should revolve with considerable facility in order to produce sufficient motion of the exterior fluid. Quick motion might also be given to the driving-wheels of locomotives, without a rapid motion of the pistons, by the intermediate of some wheels on this system between the cranks and driving-wheels. The smoothness and equality of motion which ought to accompany all the movements of properly constructed wheels on the wedge system, suggest, too, 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 the friction taken into account so as to prevent any motion which 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 cause 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 forced from the body of the boiler, the box forced upwards 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 leak, or nearly so. As the cylinders are only 15 inch diameter, it has had time for some time to work away 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 7½-inch thick, and is now a little over 5½-inch; and from its excellent condition, might well be surpassed. As indeed it was examined by Mr. Shuker and Brother's 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. The boiler originally made, the stay tubes in diameter and area 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 6½ 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 reported by Mr. Fairbairn, that from this it is not required to pull much of the stay-tubes, the circumstance is not unlike those in the fire-box, into which they had been screwed by the old threads only, and not riveted, the boiler could not have been..."
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, 1883, 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 lb. 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>
<thead>
<tr>
<th>Number of pounds on scale.</th>
<th>Weights per sq. in. on the valve.</th>
<th>Number of pounds on scale.</th>
<th>Weights per sq. in. on the valve.</th>
</tr>
</thead>
<tbody>
<tr>
<td>54</td>
<td>35-0</td>
<td>54</td>
<td>182-9</td>
</tr>
<tr>
<td>60</td>
<td>35-0</td>
<td>64</td>
<td>182-9</td>
</tr>
<tr>
<td>62</td>
<td>35-0</td>
<td>147-5</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>35-0</td>
<td>155-0</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>72-5</td>
<td>155-0</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>80-0</td>
<td>155-0</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>87-5</td>
<td>177-5</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>95-0</td>
<td>185-0</td>
<td></td>
</tr>
<tr>
<td>54</td>
<td>102-5</td>
<td>192-5</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>117-5</td>
<td>207-5</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>125-5</td>
<td>207-5</td>
<td></td>
</tr>
</tbody>
</table>

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 boiler 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-beams 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 partly-nursed fire-box, Mr. Fairbairn was of 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 80 lb. per square inch, the pressure at which the explosion occurred was blowing off, and that 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 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,—

<table>
<thead>
<tr>
<th>Safety-valve screwed down</th>
<th>h m s</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>3 1 30</td>
</tr>
<tr>
<td>8</td>
<td>3 1 30</td>
</tr>
<tr>
<td>5</td>
<td>3 45 40</td>
</tr>
<tr>
<td>8</td>
<td>3 5 0 45</td>
</tr>
<tr>
<td>5</td>
<td>3 6 45 50</td>
</tr>
<tr>
<td>8</td>
<td>3 7 20 50</td>
</tr>
<tr>
<td>5</td>
<td>3 8 30 60</td>
</tr>
<tr>
<td>8</td>
<td>3 9 30 65</td>
</tr>
<tr>
<td>5</td>
<td>3 10 30 70</td>
</tr>
<tr>
<td>8</td>
<td>3 11 30 75</td>
</tr>
<tr>
<td>5</td>
<td>3 12 20 80</td>
</tr>
</tbody>
</table>

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
sacertain,not onlynot the exact timewhat, but the ratio of increase, and the falling temperature of the steam in the boiler as the pressure progressively increased. For these objects, two delicately constructed thermometers were prepared by Dalgetty, and having adjusted Boudon'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>
<thead>
<tr>
<th>Time</th>
<th>Pressure, No. 1 gauge</th>
<th>Temperature, No. 1 gauge</th>
<th>Temperature, No. 2 gauge</th>
<th>Moist Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>2m</td>
<td>248</td>
<td>248</td>
<td>248</td>
<td>248°</td>
</tr>
<tr>
<td>4m</td>
<td>247</td>
<td>247</td>
<td>247</td>
<td>247°</td>
</tr>
<tr>
<td>6m</td>
<td>251</td>
<td>251</td>
<td>251</td>
<td>251°</td>
</tr>
<tr>
<td>8m</td>
<td>255</td>
<td>255</td>
<td>255</td>
<td>255°</td>
</tr>
<tr>
<td>10m</td>
<td>259</td>
<td>259</td>
<td>259</td>
<td>259°</td>
</tr>
<tr>
<td>12m</td>
<td>264</td>
<td>264</td>
<td>264</td>
<td>264°</td>
</tr>
<tr>
<td>14m</td>
<td>268</td>
<td>268</td>
<td>268</td>
<td>268°</td>
</tr>
<tr>
<td>16m</td>
<td>273</td>
<td>273</td>
<td>273</td>
<td>273°</td>
</tr>
<tr>
<td>18m</td>
<td>277</td>
<td>277</td>
<td>277</td>
<td>277°</td>
</tr>
<tr>
<td>20m</td>
<td>282</td>
<td>282</td>
<td>282</td>
<td>282°</td>
</tr>
<tr>
<td>22m</td>
<td>287</td>
<td>287</td>
<td>287</td>
<td>287°</td>
</tr>
<tr>
<td>24m</td>
<td>292</td>
<td>292</td>
<td>292</td>
<td>292°</td>
</tr>
<tr>
<td>26m</td>
<td>297</td>
<td>297</td>
<td>297</td>
<td>297°</td>
</tr>
<tr>
<td>28m</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>300°</td>
</tr>
<tr>
<td>30m</td>
<td>304</td>
<td>304</td>
<td>304</td>
<td>304°</td>
</tr>
<tr>
<td>32m</td>
<td>308</td>
<td>308</td>
<td>308</td>
<td>308°</td>
</tr>
<tr>
<td>34m</td>
<td>312</td>
<td>312</td>
<td>312</td>
<td>312°</td>
</tr>
<tr>
<td>36m</td>
<td>316</td>
<td>316</td>
<td>316</td>
<td>316°</td>
</tr>
<tr>
<td>38m</td>
<td>320</td>
<td>320</td>
<td>320</td>
<td>320°</td>
</tr>
<tr>
<td>40m</td>
<td>324</td>
<td>324</td>
<td>324</td>
<td>324°</td>
</tr>
<tr>
<td>42m</td>
<td>328</td>
<td>328</td>
<td>328</td>
<td>328°</td>
</tr>
<tr>
<td>44m</td>
<td>332</td>
<td>332</td>
<td>332</td>
<td>332°</td>
</tr>
<tr>
<td>46m</td>
<td>336</td>
<td>336</td>
<td>336</td>
<td>336°</td>
</tr>
</tbody>
</table>

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 324 lb. pressure per square inch. From an experimental table of pressures and temperatures, we find 240 lb. pressure to correspond to 403° temperature, and 10 lb. pressure to 212° temperature; hence we have by formula (3),

\[ t' = \frac{403 - 212}{44} = 34 \text{ minutes} \]

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

\[ t' = \frac{403 - 296}{44} = 21 \text{ minutes} \]

3rd. Let the given pressure be 60 lb. per square inch, and the boiler-pressure 300 lb., then

\[ t' = \frac{403 - 296}{44} = 28 \text{ minutes} \]

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; 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 fastening, in which, in place of being in squares of 8 inches asunder, as those contained in the boiler which burst, were inserted in squares of 4 inches asunder. The first contained sixteen squares of 20 inches area, representing the exploded boiler, or old construction; and the other, twenty-five pieces 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:

Experiment No. 1.—To determine the ultimate Strength of the Flat Surfaces of Locomotive Boilers when divided into squares of 22 inches area.

<table>
<thead>
<tr>
<th>No. of</th>
<th>Pressure in lb.</th>
<th>Swelling of the sides, in inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>245</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td>275</td>
<td>+</td>
</tr>
<tr>
<td>3</td>
<td>305</td>
<td>+</td>
</tr>
<tr>
<td>4</td>
<td>335</td>
<td>+</td>
</tr>
<tr>
<td>5</td>
<td>365</td>
<td>+</td>
</tr>
<tr>
<td>6</td>
<td>395</td>
<td>+</td>
</tr>
<tr>
<td>7</td>
<td>425</td>
<td>+</td>
</tr>
<tr>
<td>8</td>
<td>455</td>
<td>+</td>
</tr>
<tr>
<td>9</td>
<td>485</td>
<td>+</td>
</tr>
<tr>
<td>10</td>
<td>515</td>
<td>+</td>
</tr>
</tbody>
</table>

The box representing a portion of the flat surface of the side of the fire-box of a locomotive boiler composed of a copper plate, on one side 4-inch thick, and an iron plate on the other 1-inch thick, being the same in every respect as the boiler which exploded.

* 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 35 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.—Experiments on the strength of the flat surfaces of the locomotive boiler, when divided into squares of 16 inches area.

<table>
<thead>
<tr>
<th>No. of</th>
<th>Pressure in lbs.</th>
<th>Swelling of the plate in inches</th>
<th>No. of</th>
<th>Pressure in lbs.</th>
<th>Swelling of the plate in inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>215</td>
<td>65</td>
<td>4</td>
<td>555</td>
<td>0.9</td>
</tr>
<tr>
<td>2</td>
<td>475</td>
<td>27</td>
<td>5</td>
<td>575</td>
<td>0.8</td>
</tr>
<tr>
<td>3</td>
<td>635</td>
<td>29</td>
<td>6</td>
<td>935</td>
<td>0.7</td>
</tr>
<tr>
<td>4</td>
<td>355</td>
<td>31</td>
<td>7</td>
<td>935</td>
<td>0.8</td>
</tr>
<tr>
<td>5</td>
<td>455</td>
<td>32</td>
<td>8</td>
<td>935</td>
<td>0.9</td>
</tr>
<tr>
<td>6</td>
<td>485</td>
<td>33</td>
<td>9</td>
<td>935</td>
<td>0.8</td>
</tr>
<tr>
<td>7</td>
<td>615</td>
<td>34</td>
<td>10</td>
<td>935</td>
<td>0.7</td>
</tr>
<tr>
<td>8</td>
<td>635</td>
<td>35</td>
<td>11</td>
<td>935</td>
<td>0.9</td>
</tr>
<tr>
<td>9</td>
<td>715</td>
<td>36</td>
<td>12</td>
<td>935</td>
<td>1.1</td>
</tr>
<tr>
<td>10</td>
<td>735</td>
<td>37</td>
<td>13</td>
<td>935</td>
<td>1.2</td>
</tr>
<tr>
<td>11</td>
<td>785</td>
<td>38</td>
<td>14</td>
<td>935</td>
<td>1.4</td>
</tr>
<tr>
<td>12</td>
<td>815</td>
<td>39</td>
<td>15</td>
<td>935</td>
<td>1.6</td>
</tr>
<tr>
<td>13</td>
<td>845</td>
<td>40</td>
<td>16</td>
<td>935</td>
<td>1.8</td>
</tr>
<tr>
<td>14</td>
<td>875</td>
<td>41</td>
<td>17</td>
<td>935</td>
<td>2.0</td>
</tr>
<tr>
<td>15</td>
<td>905</td>
<td>42</td>
<td>18</td>
<td>935</td>
<td>2.2</td>
</tr>
<tr>
<td>16</td>
<td>935</td>
<td>43</td>
<td>19</td>
<td>935</td>
<td>2.4</td>
</tr>
<tr>
<td>17</td>
<td>965</td>
<td>44</td>
<td>20</td>
<td>935</td>
<td>2.6</td>
</tr>
<tr>
<td>18</td>
<td>995</td>
<td>45</td>
<td>21</td>
<td>935</td>
<td>2.8</td>
</tr>
<tr>
<td>19</td>
<td>1025</td>
<td>46</td>
<td>22</td>
<td>935</td>
<td>3.0</td>
</tr>
</tbody>
</table>

The flat box in which these experiments were made has the same thickness of plates as that experimented upon in the preceding table, viz. 2 ft. 4 in. thick, and the other of iron 0.38 in. 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.

From 905 to 1295 lb., the swelling or bulge on the side was insensible.

Failed by one of the stays drawn through the iron plate after sustaining the pressure upwards of 14 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 the interior of 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 surface between the plane of the stay and the copper, or in other words, as the copper reduces in area, the strength increases in a higher ratio than the increase of space between the stays. Thus according to the mathematical theory, we should have—

Ult. strength 2nd plate per sq. in. = strength 1st plate \[\frac{x}{1} \times \frac{x}{2} = \frac{815 \times 1295}{1295} = 1718\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 0.38 in. diameter, such as those which formed the support of the plate 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 copper, 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 that riveted at the end is therefore in the ratio of 100 : 78, 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 thread of the bolt; O, O', O, O', O', the centres of the squares formed by the bolts. Suppose a pressure to be applied at each of the points O, O', O, O', O', 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', and similarly fourth of the pressure applied at O', 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—

Strain on the stay of Table III. = \( \frac{815 \times 25}{2240} = 9 \text{ tons.} \)

Strain on the stay of Table IV. = \( \frac{1295 \times 16}{2240} = 11 \frac{1}{4} \text{ tons.} \)

The stay in the latter case was 0.38 in. 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 Fahr. 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 incomensurate 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 water on the other, increases the difficulty of making 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 900°. 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 subjected in locomotive 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. Rambotham's experiments on a larger scale; and by extending the test to copper stays as well as iron ones, it was considered that doubts could 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 0.38 in. diameter, screwed into a copper plate 0.38 in. thick (as fig. 3).

<table>
<thead>
<tr>
<th>No. of Experiment</th>
<th>Weight in lbs.</th>
<th>No. of Experiment</th>
<th>Weight in lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15,500</td>
<td>2</td>
<td>16,600</td>
</tr>
<tr>
<td>3</td>
<td>18,200</td>
<td>4</td>
<td>18,200</td>
</tr>
</tbody>
</table>

With the last weight, 18,260 lb. = 81 tons, the threads in the copper plate were drawn out or stripped after sustaining the weight a few seconds.

Experiment II.—Iron stay 0.38 in. diameter, screwed and riveted into a copper plate 0.38 in. thick (as fig. 4).

<table>
<thead>
<tr>
<th>No. of Experiment</th>
<th>Weight in lbs.</th>
<th>No. of Experiment</th>
<th>Weight in lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15,500</td>
<td>2</td>
<td>18,290</td>
</tr>
<tr>
<td>2</td>
<td>16,600</td>
<td>3</td>
<td>19,940</td>
</tr>
<tr>
<td>4</td>
<td>21,200</td>
<td>5</td>
<td>23,300</td>
</tr>
<tr>
<td>6</td>
<td>24,140</td>
<td>8</td>
<td>24,140</td>
</tr>
</tbody>
</table>

* When the last weight, 24,140 lb. = 107 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.
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 Board of Sewers, and was read at a special meeting held on the 15th 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 part 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 superiority of that 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.**

<table>
<thead>
<tr>
<th>No. of Experiment</th>
<th>Breaking weight in tons</th>
<th>Resistance per sq. inch</th>
<th>Ratio, Exp. III, the iron stay and iron plate taken as 1000.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>12.5</td>
<td>27.7</td>
<td>1000 : 1000 Iron and iron</td>
</tr>
<tr>
<td>II.</td>
<td>10.7</td>
<td>23.6</td>
<td>1000 : 856 Iron and copper screwed only</td>
</tr>
<tr>
<td>III.</td>
<td>9.8</td>
<td>20.1</td>
<td>1000 : 756 Copper and copper screwed</td>
</tr>
<tr>
<td>IV.</td>
<td>2.2</td>
<td>14.7</td>
<td>1000 : 576 Copper and copper screwed</td>
</tr>
</tbody>
</table>

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 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 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.

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 agree 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 lower sewers, and to abandon the shallow 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 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.

The design 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 interception sewer as one of the most important features of the scheme on which I am now reporting, and, indeed, without it everything else, 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 manures presented in 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, I have received from them the most 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.*


The main part of this derrick consists of an upright frame $a$, 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 $e$, with the mast secured on it. $f$ are double capstans; and $r$ are reels for taking up 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 $e$, 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
real; 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, capstan, etc., 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.


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
halve 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 setscrews one of
them in front and the other in rear of the shaft $G$; $J$, 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 $g$, alides 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 Henson, 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 eccen-
tric 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. $a$, is the centre portion or boss of the main driving-
crank; $bb$, the eccentric for working the pumps; $c$, the crank-pin,
to which motion is given by the engine; $d$, the crank-shaft.
The eccentric $bb$, 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.

[Reprinted from the Journal of the Franklin Institute.]

Rotary Engine. 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 worked over 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 3. The moving head of 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.


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 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 movable tongue and cam projection, acted upon by the edge of the paper and the motion of the feed-rolls, 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 movement is changed in 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 guiding-rod, 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 of two bevelled 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 bevelled 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 being alternately worked over 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 3. The moving head of 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.


The inventor does not claim a split or jaw socket having a screw and screw-nut applied to it for the doing 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 in such a way 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.


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 Coats. 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; and in 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.

Fires 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 Lathe. 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-arbor, fitted to turn on each other, and adapted to receive a bell-crank, 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.
The Civil Engineer and Architect's 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; or, if combined with a spring, to be able to charge each tube independently of the others, whereby 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.

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 the angle of the plough 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.

Claims.—A dye 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.

Snow-Ploughs for Railroads. A. Hall and S. Sturtevant.
Claim.—So shaping, proportioning, and placing the noted 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.

Controlling the Pressure of Steam. H. S. Williams.
Claims.—1. Opening the water-cock of the steam-boiler for the purpose of letting off 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.

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 pre-serve 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, such 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.

Corrugated 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.

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 on the crushing-wheels within its outer diameter or periphery, thereby giving the periphery a slip or sliding motion upon the quartz.

Railroad Chair Machines. M. M. Gray.
This invention consists in passing 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 combine the same into the shape of a railroad chair.

Claim.—Operating the sliding former or mandril upon the base or pedestal to keep it firm and cool, and cutting, curving, and wedging the plates of metal to be formed into the chairs while in a stationary position, and at a proper heat, 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.

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 cutters 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 simultaneously 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.

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 Stonehousehill 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 Edgecombe, northward and westward, protects the town from the west-gates, and from Staddon-heights from the south-east-gates, 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-clate, and dunstone (a semi-crystalline rock, which protrudes between the clay-clate 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 3° higher than prevails on the coast of Sussex and Hampshire; 29° higher than that of London, and 5° or 6° above that of Northumber-land, and been in too frequent use to time to time to the extent of 162 miles, but they have been laid down without any plan, or reference to the natural facilities of the locality. Of these 162 miles of sewers, 20,747 lineal feet were constructed by the Commissioners of Devonport, and 55,866 lineal feet by the municipalities 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., Mutten-cre, the Chamber in the dockyard, and at North-corner. The seaward 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 is discharged into the sewers and not worked out by means of subsids 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 subsid in the numerous low-lying districts is not covered with such 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 1000 and 3000 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, Cowaic, and Blackbrook. The subsid of the gathering-ground is for the most part decomposed granite, in part covered with peat. Water from the West Dart and Cowaic, after being brought very pure; that from Blackbrook 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. Devonport has several natural agents which cause the company trouble: in summer evaporation carries off much water, and at all times the subsid absorbs a great quantity, and in winter frost and snow impede the flow. It is not uncommon for the last 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 water sufficient to supply them. The 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, Stote, and Morice-town; about 351,000 gallons by the government establishment in the dockyard and inhabitants of East Stonehouse. There are about 3,000 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 18s. a year; some of the houses are charged 16s. a year water rent: the supply is intermittent.

The West Dart river is brought into the Cowaic round a lofty mountain, then the Cowaic is brought into the Black-brook, forming the Devonport leat, which travels round Royal and passes underground for the space of 3000 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 Stannalake-bridge, the river Meavy—the main supply of the leat is lost in this part. 30 miles further, at Stannalake, from which point the leat 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 is used to supply the city. 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 is used to discharge into the old reservoir in Devonport, 136 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 Remmey introduced stoneware pipes, which proved total failures, the material not sustaining the pressure, and the joints giving way. In 1832, the company established the present reservoir at Stoke-Damarel, containing 2,000,000 gallons, and supplied by a pipe brought from Brooklands, in the line of the tunpike-road. After taking what the company supposed to be good engineering opinions, a 1-inch pipe, having the immense natural fall, was laid, which proved totally inadequate for supplying the reservoir, and was removed to the third or fourth part of the water from the leat. This reservoir-pipe, and other improvements, cost 18,000l. or 17,000l. However, the Stote 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 a ground reservoir, situated within the Lines, and consisting of three chambers 73 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, 186 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 New Row, where many 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 last 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 Morice-town—most defective method of supplying water to the inhabitants, the water being drawn direct from the leat. In consequence of the uncertain supply derived from these sources, evaporation in summer, and frost in winter, when it is no uncommon thing for the last 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, and to endow the town with a respectable water supply, to the entire satisfaction of the inhabitants, and legal dis-
abilities in the way of transferring the freehold of the land
selected by them at Brooklands, together with other inescapable
difficulties incident to a neighboring manufacturing 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 a main from the site of the Snakes-knole 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-eastern boundary of the parish, and the top water to
be about 130 feet above the water mark on the dockyard gauge.
Its clear contents are to be in amounts of 1,000,000 gallons; the total reserve with existing reservoirs would then be
31,000,000 gallons, calculated to serve the inhabitants and
government for thirty-one days. These calculations emanate
from Mr. A. M. Hampton, and do not appear at all satisfactory to the
councils of the Town Council, who produce evidence against
them, the suggestions of Mr. A. M. Hampton 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 reservoir at Mewsey should be capable of supporting
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 15 feet on the average would contain 4,000,000
or forty-five acres would contain 180,000,000 gallons, being
adequate for 180 days at 140 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
meadows and pastures to admit water from granite mountains, elevation, a great breadth of available land
so that no water, 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 abnegated state. Water is obtained from open streams
as if the surface contamination: it is conducted to the towns
by means of open channels, ‘leaks’, contouring hill-sides; passing
through farm-yards, cultivated lands, and receiving surface
washings, without filtration, from these, as also from adjoining
roads. Water, collected is distributed for use intermittently,
through cast-iron mains and lead service pipes. Filling and
emptying the mains produces rust. The open leak admits mud
and other contaminating material; light and air produce vegetation
and animalcule, so that at no time is the water fit for drinking.
The intermittent mode of supply compels the people to run to
the fields, open pastures, potable wells, public fountains, which expose it to all the gaseous contaminations of crowded
wellings. 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
his or his house, 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 footways, channels, lanes,
coasts, alleys, backets, &c., as also for watering streets and
roads both in the balance of power, services. A public
may sell in bulk for these purposes, and profitably, even at com-
paratively 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 suc-
cessive losses. The company must continue what either of their
works at its value 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
aqueducts, covered and preserved, from which water 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
dispute that the office of supplying the inhabitants of the towns of
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 1,000 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 doubles that of the average of all England, and the mortality is
about 7 in each 10,000 over the last ten years.

The Report sets forth—“That a new and complete system of
drainage, a full and pure water supply, and efficient street clea-
ning, 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 equal and excessive; that the sewerage and drainage
is limited in extent and defective in practice, without any sys-
tematised plan of procedure; that the present system of cleansing
streets and removing horse refuse is imperfect; and recommends
the formation of public baths and laundries, 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 FYN, Patentee, March 29, 1823.

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 mopping, the potentate 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 sleeper,
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 position 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 patentee remarks, that they are
aware that the working cylinders of steam-engines have been
hereafter 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
the invention has not been found considered in conjunction with
involving 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.


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 his book, as it can enable, 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-Reformationism; 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 decree.

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 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 in effect, but not what he purported to be the doctrine of his art; it is not such a middle daughter. 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 bepraised and belauded by the confraternity of Puseyism 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, we would have to thank him, from openly-avowed Puseyianism, listened on a subject of art; they admired his eloquence, his subtlety, his fervour, as they would those of a Jesuit preacher. Profitting by this reception, Mr. Ruskin, having got the ear of the public, has proceeded until he is a recognised mission to the lands of Ruskinism. 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 aesthetics, attach themselves to symbolism, and catch the ears of the unwary country parson, who, straightway gives himself up to the vesica piscis, to sacred monstrosities, and candles lighted or unlighted. Young ladies of pious aspirations, who are content to marry curates and make love to vicars, are led to embroiler altar-cloths instead of splicers, and to decorate the church instead of the boudoir. The lover of song is awakened to the horrors of the neasal twang of church and lends himself eagerly and hard, the thinking that his part in the play is subservient to that of Pope. Gregory himself, whose Hildebrandish pretensions are the real aims of his art-loving readers. 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 there exists an Augustinian. The spirit, the original spirit of the middle ages will always find fitting copyists in narrow-minded pedagogues and over-weening personages. 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 lunatic notion of restoring the dead, which they are ignorant orheedless 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 national freedom and individual independence, which are the best and most 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 the spirit of a Dante, a Chaucer, or a Wickliffe enters into the proceedings of the mediævalists; how little do we see of the freedom of genius, of the true and untrammelled 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 the confinement within fetters of which priests indeed bear the keys, but which are never used to unlock. The incalculable a mind-debasing mysticism is as glorious as the confessors, and the 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 unashackled in order to have free scope. Degrading restrictions are however laid down to trammel the aspiring; to one style of architecture his exertions must be confined, and the precedents of the ancients and the dictates of the priest are to be his strict guides. The canons of taste are to be abandoned for the mystical and colossal, and forms, trumps, septenaries, 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 the consequences of the latter conceding to them of the triumph of eclecticism. Mr. Ruskin and his fellow-disciples believe and wish, the slave and tool of the priest, we should never have witnessed these 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, in 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 Aethenians and modern Athens beyond the degree of Scotch laudation, and that distribution of mutual and reciprocal praise in which the lowlanders proverbially indulge. On the strength of this good opinion, Mr. Ruskin tried to persuade the factitated ears of his auditory the choicest dogmas which distinguish his system; but fortunately he has gone further, and having printed his lurubrations, he has given his dupes the opportunity of scanning at leisure those passages which in their delivery too readily met with approval. But, as has been said, "but not the least reason as 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.
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL.

231

to his listeners, and his own system is one of paradoxes and of mystical formulas. Thus is brought together a mass of contra-
dictions, such as it is. But in addition, to say, that the Jesuit is a 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 at the height of all the unspeakable, the north affords the Puritans and medivalists 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 reduced me to the same conclusion that all architecture was to be of brick and stone; and may not with some justice be gathered from the probable use of iron, glass, and such other materials in our future edifices. I cannot now enter into any statement of the possible use of iron or glass, but I have always a mind to 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 dis honoured 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 recommendation. I do not see how we can learn anything, and I think that the Bible employs are likely to be clear and intelligible illustrations to the end of time. And perhaps it is true that even in the mind of every man 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 indeed that the arch is a symbol, and the arch always in the mind of man. A symbol of carved stone, and usually 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 Stones, as used throughout Scripture, would completely destroy the notion that man was ever necessary 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 perhaps it is of no account. If it is, I know not 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 fill 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 affront 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 to do for architects, and about the new style he was to produce, it turns out that his great system is to introduce the medieval styles in all their completeness; a doctrine needed by no new expounder 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. Ruskin has an extra word or two.

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 nomenclature of Ruskinism is a waste of print and paper, we hardly know whether we are justified in stating that the following passage of bayonety 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 roof-
ing any space, as a window or door for instance, or a space between pillars, or a character of Greek way as it would 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 the present system, of which nothing was more than a diachronic imitation of the Greek; but I mean the architecture in which the Roman spirit truly manifested itself, the magnificent vaultings of the aqueduct and the baths, and the colossal height of the rough stone arch, which is much the same as an arch, full of expression of gigantic power and strength of will, and from which are directly derived all our most impressive early buildings, calling what is called this.
PREVENTING COLLISIONS ON RAILWAYS.

W. Gorling, 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-rod is attached to this lever, which raises the break, turn off the steam, and ring a bell to advise the driver that the driver's bell is wires, which pass under each of the carriages, and by a peculiarly constructed crank the bell can be run 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 elastic so that the train would not pass over more than fifty yards after the breaks are applied; consequently no 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 a furnace, not 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, 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 plaining, boring &c., brushing back of steel and other metal articles, two similar rollers formed of soft wood, with emery or soft 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 give a glance 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 requisite from 1531 works of art within the given space. What a pity it that each and every single visitor has not 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 monotonous 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 described his favoured effort in some spot unnumbered, and 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 plopping, gazing public who go in and out, stimulating, anticipating a feature on the Shelf before them; and so on, and so on, until the "right good old still" at the "Cheetae" of No. 1, follow on seriatim till a bewildering surfeit comes over them, and they make a hasty exit, but with chromatic tropes of the pictures they have beheld, but with sensibly similar necks, aching heads, and strained optics;—we wish it were otherwise. How can the public 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 preoccupations 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 (July) at the Institute at South Kensington, 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 colleagues. The ceiling, the windows, the woodwork, and those 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 time is passing when the architect was the architectural artist; the building of the great assembly of art-disciples who come here year by year for instruction, is he surely neglecting a duty when he leaves it to the inferior members of his profession to disseminate measure or false teaching, without let or hindrance.

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 architectural drawings. However, they 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 house of Inigo Jones, including his full design for the Whitehall palace; views of old St. Paul's, as altered by him; an 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, Colleshill, and other uses; and in the distance his mansion on the Tweed, 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 monotonous 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 described his favoured effort in some spot unnumbered, and 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 plopping, gazing public who go in and out, stimulating, anticipating a feature on the Shelf before them; and so on, and so on, until the "right good old still" at the "Cheetae" of No. 1, follow on seriatim till a bewildering surfeit comes over them, and they make a hasty exit, but with chromatic tropes of the pictures they have beheld, but with sensibly similar necks, aching heads, and strained optics;—we wish it were otherwise. How can the public 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 preoccupations 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 (July) at the Institute at South Kensington, 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 colleagues. The ceiling, the windows, the woodwork, and those 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 time is passing when the architect was the architectural artist; the building of the great assembly of art-disciples who come here year by year for instruction, is he surely neglecting a duty when he leaves it to the inferior members of his profession to disseminate measure or false teaching, without let or hindrance.

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 architectural drawings. However, they 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 house of Inigo Jones, including his full design for the Whitehall palace; views of old St. Paul's, as altered by him; an 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, Colleshill, and other uses; and in the distance his mansion on the Tweed, 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.

The secret of this result we, in England, have yet to learn. Near Mr. Fulkener's drawings is one by Mr. M. D. Wyon (1196) of the Pompeian house now being erected in the Crystal Palace, in which the original plan and coloured engravings form the 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. 1236 is the "Town Hall at Leeds" about to be erected from the designs of Mr. Bredick. 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 present restoration of the Nicholas Hawksmoor Church of St. Peter's, Westminster, has been 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." (1136), in which arches in various directions, springing from columns, are judiciously introduced; the room is partially lighted by glazed windows, the whole being described as "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 some parts. It is designed for the same purpose as the new chamber in the old town hall. 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 paper can be overruled 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 facade would have been improved. The great feature in the plan (and it shows externally) is the large open staircase, screened from the street by colonnades, &c., in the main line of the front, "on the Scotch principle," as it is expressed in the catalogue. In (1131) "Chambers erected in New
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL

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 Workhouses of Messrs. J. and R. Morley, Wood-street, Cheapside, built under the superintendence of Mr. J. Waley.” This is a very fine range of building, reminding one of the similar structure, now in Manchester, and in various parts of the country, as well as in the Craven Hill case, the shape of flying buttresses, as if from nave over aisles, is taken advantage of (of the wall of course filling them up in reality), while the ridge acts as a constant coping piece. Indeed, as far as I can perceive, the work is artistic, and I believe we have not seen for a long time. Unhappily (or perhaps by a sly humour, in terrreor, if we can suppose the hanging committee to be wagging), 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 be a drawing which will be interesting on account of its clever conception, and as we overheard the remark, a decided “inflation!” Possibly this latter word may be applicable also to Mr. Betto’s “Design for a Church Exterior” (1183), which we are not skilful enough to criticise.

Mr. P. F. Cockrell has three excellent drawings; the largest (1206) is called “Thanksgiving in St. Paul’s after the Victory over the Spanish Fleet, 1718,” but is in reality a nearly-zenital aerial view. From a glance at the surrounding buildings, we learn that Messrs. Cook’s great warehouse was in progress of building at the time, and the church, as here shown, was completed the other day removed! This bests 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. Sales, H. Jenkins, De Fleury, Drueke, and others. Mr. W. J. D. Deane has produced a “Sketch of the Interior of a Church at Capri, Bay of Naples” (1113).—Mr. Macquoid has two from Spain, viz., “The Doors of Toledo Cathedral” (1139), hung so high that the details, which seem curious, cannot be examined; and (1118), “The Court of the 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 (1190), and the other by J. Chase (1210)—both very good; in the former especially, the Cathedral is perfectly detailed. Mr. L. E. Falkner has produced, from the statue of the Prince of the Peace, in the Palace of Justice, Rouen (1840); and the Hotel de Ville, Ghent (1844). In (1194), we see a most elaborate elevation of Giotto’s “Campanile di Firenze” (F. Oliver), which, nevertheless, gives little idea of the real effect. (“We do not say this depressingly of the drawing.”) In (1329), 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 ages and countries.”

The few old English buildings that have been depicted will suffice to enumerate,—Lichfield Cathedral, (1125); and York, (1191); Eltham Palace, (1814); Wootton Church, Gloucestershire, (1118); and the North Doorway of Stone Church, Kent, (1817); Timperley Abbey, (1119 and 1839); and Winter-Gate Row, Chester, (1296).

We shall call attention to a few other drawings exhibited, of works in progress. We find (1183), 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 unmistakable sympathy with Wollaton Hall, near Nottingham. There is a touch of the severe in the exterior of what it is proposed to be the leisurely residence of a Cool- man in the Country, “Ashenmore, W. G. Pennington” (1104), 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 (1101), very elaborate, and revealing in Jacobean oddities. Mr. Andrews, whose former exertions at the time; and the scaffolding and beams of a prettily viewed picture of the Winter-Garden the possession of J. Thomas (1163). The architecture seems brought into too violent contact with the slender metal work and glass, and there seems an unsuitability in the four-columned portico, besides its being heavy. “Sonning Old Hall” (1182) is another very beautiful design; “Somerleyton Village” (1190), 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. (1186), “Ince Blundell Hall, Lancashire, with Hyde Park, from designs by A. Triman (1179). In both these, as well as (1845), 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 (of the wall of course filling them up in reality), while the ridge acts as a constant coping piece. Indeed, as far as I can perceive, the work is artistic, and I believe we have not seen for a long time. Unhappily (or perhaps by a sly humour, in terrreor, if we can suppose the hanging committee to be wagging), 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 be a drawing which will be interesting on account of its clever conception, and as we overheard the remark, a decided “inflation!” Possibly this latter word may be applicable also to Mr. Betto’s “Design for a Church Exterior” (1183), which we are not skilful enough to criticise.

Mr. P. F. Cockrell has three excellent drawings; the largest (1206) is called “Thanksgiving in St. Paul’s after the Victory over the Spanish Fleet, 1718,” but is in reality a nearly-zenital aerial view. From a glance at the surrounding buildings, we learn that Messrs. Cook’s great warehouse was in progress of building at the time, and the church, as here shown, was completed the other day removed! This bests 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. Sales, H. Jenkins, De Fleury, Drueke, and others. Mr. W. J. D. Deane has produced a “Sketch of the Interior of a Church at Capri, Bay of Naples” (1113).—Mr. Macquoid has two from Spain, viz., “The Doors of Toledo Cathedral” (1139), hung so high that the details, which seem curious, cannot be examined; and (1118), “The Court of the 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 (1190), and the other by J. Chase (1210)—both very good; in the former especially, the Cathedral is perfectly detailed. Mr. L. E. Falkner has produced, from the statue of the Prince of the Peace, in the Palace of Justice, Rouen (1840); and the Hotel de Ville, Ghent (1844). In (1194), we see a most elaborate elevation of Giotto’s “Campanile di Firenze” (F. Oliver), which, nevertheless, gives little idea of the real effect. (“We do not say this depressingly of the drawing.”) In (1329), 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 ages and countries.”

The few old English buildings that have been depicted will suffice to enumerate,—Lichfield Cathedral, (1125); and York, (1191); Eltham Palace, (1814); Wootton Church, Gloucestershire, (1118); and the North Doorway of Stone Church, Kent, (1817); Timperley Abbey, (1119 and 1839); and Winter-Gate Row, Chester, (1296).

We shall call attention to a few other drawings exhibited, of works in progress. We find (1183), 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 unmistakable sympathy with Wollaton Hall, near Nottingham. There is a touch of the severe in the exterior of what it is proposed to be the leisurely residence of a Cool- man in the Country, “Ashenmore, W. G. Pennington” (1104), 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 (1101), very elaborate, and revealing in Jacobean oddities. Mr. Andrews, whose former exertions at the time; and the scaffolding and beams of a prettily viewed picture of the Winter-Garden the possession of J. Thomas (1163). The architecture seems brought into too violent contact with the slender metal work and glass, and there seems an unsuitability in the four-columned portico, besides its being heavy. “Sonning Old Hall” (1182) is another very beautiful design; “Somerleyton Village” (1190), 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. (1186), “Ince Blundell Hall, Lancashire, with
the Intended Additions and Alterations, by J. J. Scolar," is a good Italian pile. Gelly Dég, Carmarthenshire, by W. W. Jenkins (1192), 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 Leverestoke House, both exhibiting considerable piquancy and good taste in design and in the treatment of the windows, with the long feeling for the mental." (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 pimply battlements. (1168), "Mansion at Harrow, F. Barnes," is not much prettier in design or in the treatment of the windows, with the long feeling for the mental by Mr. J. K. Colling (1924), 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 (1180), Toner Lodge, Down, Kent, by J. Tarrant, 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" (1904) is better than the design, but 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 (1180), Mr. Talbot Bury's Almshouses, New Road, Berks, which has moreover a thoroughly quaint look; and we do not practice as some do in describing this one, of 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 (1150), one for Cheltenham, by G. F. Bodley. Every detail in this evinces considerable taste and study, and there is an ingenuity in the several windows and chimneys. Effect is also gained by varied materials. Mr. Ferrey exhibits a small drawing, which is of this class;—"Buildings of Brick, for Educational Purposes, in Ireland" (1838). They appear plain, and rather monotonous.

We recognise Mr. Hardwick again in (1811), "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 those 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 most unpleasing effect. We understand they are to light a series of dormitories; but could not those have been differently planned?

The two drawings of cemeteries and cemetery chapel do commend themselves to our good opinion. "The Lambeth Burial Ground," by T. H. Catter and Almack (1808), is in the worst possible taste in every respect. "The Cemetery Chapel now erecting at Hanwell, by Mr. T. Allom" (1770), cannot be recondemned even by the pictorial talent of the artist.

"The Clock-Tower for the Market-Square, Geelong," designed by James Edmo stole, Jun. (1239), will attract attention from the novelty of the subject. We have observed 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 spaces between the constructive skeleton, and also serve for varying the colours. None of the tiles are to be glazed, being wholly aimed at attracting attention, and there is 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 year 1811 is a very good year for such things. 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 very careful detail it contains; as a picture, it has an unfinished look, and in the situation where it is placed, 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 enclosed), 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 architecture of the same gentleman, exhibits (1170), "Elstree, Herts, as Rebuilt" by him,—a plain, sensible-looking structure. Mr. Horton 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 same year he publishes a essay on "Chapel Windows, with the Gothic," 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,—but this is on a piece of 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, with a foregone conclusion that the proportions might be distinguished, 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. (1103) is Woolpit Church, Suffolk, showing the new tower and spire being erected from the designs of Mr. Phispen, 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 extremely commonplace; and so are all the 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 obtuse perhaps in such matters as very pointed windows with very short jams, 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 each side. (1159), Decoy Church, Havant, by Mr. R. F. 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 praisingly, instead of being merely an unimportant quite unimportant of the rest, 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 Decoy Church, &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 way would have left us a large bifolium. We cannot 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.

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. Giugel, of Bristol, and Mr. T. R. Lyneagh, of London, which is to be carried out under their superintendence. The proprietor is the Rev. R. E. Barry, of London; the premium of 30l. to Mr. J. Gibson, of London; and the premium of 20l. to Messrs. Gabriel and Hirst, of Bristol, for their designs. Upwards of fifty individuals submitted plans for competition.
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL.

INSTITUTION OF CIVIL ENGINEERS.

APRIL 25.—JAMES SIMPSON, Esq., President, in the Chair.

The discussion being resumed on Mr. D. E. Clark's "Description of the Deep-Sea Fishing Steamer, Enterprise, with Rudder and Propeller." in allusion to the former experiments, it was shown that the power required for the propulsion of the Enterprise, at 94 miles per hour, was 33 indicated horse-power, which is estimated as a sufficient horsepower for resistance, found on the results obtained by the Rudder; this power was, it appears,

was stated in the paper, (40-horse-power,) with which also the
stated consumption of fuel was in accordance.

The power required to the assumed loss of power in communicating
the water to 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 of the water, and in water, and on the sea, would
be reduced, and if the necessary engine-power was equal to that which could raise the quantity of water required for prop-
ulsion, from the level of the sea to the height due to the velocity of
velocity. On these principles, it was calculated from the data contained in
the paper, that in the management of the water, exclusive of all fric-
tional resistance, the ratio of power to effect was,

The power used = 12 to 18 horse-power
Ditto wasted = 3 to 4 ditto
Total = 15 to 22 ditto

and it was concluded that there was much to be said in favour of Routh-
ven's mode of propulsion. The statements as to the former experi-
ments, viz., that the engine-power required to raise the velocity of 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 verti-
cally, 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 por-
tion of fluid was, as it were, lifted from the level of the deck; then a certain amount of power would be expended in changing the con-
tion 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,
vis., 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
pressures were measured and estimated, and it was contended that the
contrary inference led to inconsistent and absurd results. But in the
paper 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 is immediately increased.

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, it = 3 1/2 feet; then that
double would = 17 1/2 feet = 1/3 foot (the height of the area above the seat
would give a total height of 18 1/4 feet; also = 22 feet (the quantity of
water per second) x = 60 (seconds per minute) and = 128 feet
the quantity of water raised one foot per high minute, per horse-power
gave 11 horse-power; thus 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 = 50 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 pressure 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, or the power was given to the water; putting
V for the speed of the boat, and V' for the efficient velocity of the water, with respect to the nozzle from which it issued; then the power expended being taken as unity, the useful effect was found to be represented by

\[ 2V - \sqrt{V^2 - V'^2} \]

which showed, that when the forward speed of the vessel and the efficient
speed of the water were equal, there was no useful effect; and that the
maximum useful effect was obtained when the efficient 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.

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 result.

In his account of the reaction to be expected, the author had, shown, by
experiment, that the reaction was measured by the weight of a column of
water of twice the height 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
for a long time; when the water was permitted to flow out freely, an
unbalanced pressure of one and a half the hydraulic 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 half the power expended, it was contended that the equations 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 reaction; now, the fact is that the vessel necessarily discharged the
water, but it also previously drew it into the vessel by expiration;
and it was contended, that, under these circumstances, the
maximum effect was obtained when the speed of the vessel was equal to
the efficient water velocity, so that the effluent water was equal 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 Routhven's propeller, it was agreed
that in numerous situations from the practical point of view, there were
practical advantages over the paddle and the screw; and that the subject
demanded further inquiry and investigation, theoretically and experi-
mentally.

---

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 Report of the Juries for the Exhibition of 1851 (Class V.), "that
an instrument had hitherto been so perfected, as to satisfy the condi-
tions of a good meter," the paper gave a list of the patented
water-meters from 1824 to 1851, and then proceeded to explain succinctly
the several systems hitherto employed under the several classifications of,

1st. The Diaphragm principle.
2nd. The Water-wheel.—Mr. Parkinson—The Spiral Faz—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
degeneration from wear and tear.

The second class was the most numerous; and among the machines
described were those of Mr. Taylor, Mr. Simons, Master, Trowbridge,
and Adamson, and Captain Ericsson; who were considered the best. All
those 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 the former, there were all kinds of wheels for registering;
and the water was passed 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, with the result that, in order to be given to the water the
motion which had been made by Mr. Taylor to remedy this defect, by using a gutter-percha drum
of the same specific gravity as water; but though the meter thus
arranged measured correctly under full pressure, it varied much when
the pressure was low. The spiral screw, or the fan, on the other hand,
were all directly proportional to the pressure, and their inventions were
everything to the 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 identical in all but few points. The reciprocating fluid
meter, also invented by Captain Ericsson, was shown to have been used to some extent in the
United States, and to be more effective in its action. Measra, 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. Haigh, Blackall, and Co., of Salford, which was described by us last month in a paper read at the Institution on another subject. In that state it is said that a certain quantity of water might allow a considerable quantity of fluid to pass unmeasured, at low velocities, that such a small amount as might be necessary for such purposes as might be required. In the discussion many water meters were mentioned, and among them the various measuring machines introduced by Mr. Siemens were described. The general opinion was that although there was 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 equation 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 the machine, immediately below the Morris Town; their construction issued through tangential apertures into the surrounding casing. Inasmuch as the outlet would act to some extent in the manner of jets, this drum would revolve proportionally faster at high velocities, to counteract the tendency to float them entirely out of the receiver, by 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 effectively protected, by forming a closed chamber at the center of the disc, into which there entered an upright stud with a steel point, shutting 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, and the graduated meter, that is, the plan, which had, by a 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 circumstantial hindrances, the friction 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 steam.

May 9.—The paper read was "A Description of the Sliding Caisson at her Majesty's Dockyard, Keyham, Devon." By W. Fairhaidh, M. Inst. C.E.

The substitution of caissons for the ordinary lock-gates, and their employment in connection with the water channels, 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 its being necessary to float them entirely out of the receiver before a vessel could pass, rendered them applicable only for special localities. The great extent of opening required for the passage of ships of war, induced a rather general use of such caissons in the Royal Dockyards; and in the Keyham, which was considered as having 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 that it could resist the entrance of the water, efficient to close the entrance, and 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 River Tamar, 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 was thought desirable in constructing 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, part the channel, the new caisson was tried. It was designed by Mr. W. Smith, of the Admiralty, and was constructed by Mr. W. Fairhaidh, by whom a description was transmitted to the Institution.

The form of the caisson was that of a rectangular vessel, 32 ft. 6 in. long at the top, 78 ft. 6 in. long at the bottom, 42 ft. high, and 18 ft. 6 in. wide; it was built of wrought-iron plates, varying in thickness from 4 inches at the bottom, to 1 inch at the top, well supported throughout by an inside framework of angle-iron and gusset-pieces, and through two decks of iron and one of timber for the interior arrangements, but was so constructed that it could be let in chalk full of water. The plates were connected by "butt-joints," covering plates attached by double and quadruple rows of rivets, and at the bottom and ends were securely lapped, and fastened upon the deck, and against the jambs when the caisson was in its place. The interior arrangements of the caisson were such, that when it was required to withdraw it from across the opening of the lock, thereby opening a valves, to draw the water out of the drainage running along the bottom of the lock, and to allow the body to rise a few inches from the bottom caisson, 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 monastery, at right angles with the lock, leaving an opening of the clear span, and after the passage of the ship, it was drawn back to its position, and by the way, as settled it securely on its bed or sill. 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 time taken being shown to be 290 tons; it contained 38 tons of iron balls, and had an internal capacity for 333 tons of water. The mechanical arrangements were minutely described, and the general result appeared to have been very successful, from very successful. A 260 ton weigh in the direction 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 lock. The caisson, when in its position, took about sixty tons to move it, leaving the ground firmly secured. The case of a Barker's mill was adopted. The water entered the rotating disc enclosed in a sealed oil chamber, and the graduated meter, which had, by a 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 circumstantial hindrances, the friction 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 steam.

May 15.—The paper read was "On the Fatigue, and consequent Fracture of Metals." By F. Bluntworth, M. Inst. C.E.

Many accidents, 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 containing 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 reproduced constantly; if the disturbance of the particles took place, the metal was deteriorated, and that part subject to the reiterated strain was so far destroyed that it ultimately broke down. This might also arise from sudden concussions, as from a load on a girder, which was under a state of stress; these 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 raft in a London brewery, carried on the water by a girder, by which it had been supported for six years; it 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 increased load of the raft had added to the strain, causing the whole raft to break, with the raft. An example of this nature was given, and it was shown, that the reversed 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-rod of the shafts of locomotives were subjected, had produced very serious results, which it sufficed to point out forcibly to guard against the recurrence of the accident.

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 strain, either continued at intervals, or, as the case might be, 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 parts of machinery, or 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 Cannibalism of Tunnelling, with examples," by W. M. Fenston, 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 Wiltz and Somerset Railway. The materials had been collected from the author's diary of the proceedings, and it had been his intention to present more detailed the practical exams for the workmen and 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 opened by the system of cross-cutting, 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 was raised to a height of over 50 feet, and the work was conducted through strata generally dislocated, and not to be depended upon. In sinking the shafts, the water brought up in the shafts did not produce serious failures in the timbering, which required to be renewed and replaced several times. Numerous contrivances were essayed for the purpose of supporting the roof, 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
inclement pumping could therefore be relied upon; but the consequence of the shafts sunk badly, until it was retained by a hanging kerb 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 water and sand 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 sphon, which was accordingly laid down; it was formed of cast-iron pipe 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 disposing of the water, and also of the partial effect 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 detailed of the circumstances undergoing the manipulation of the different works, 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 a, which manufactures and architecture; such as carpenter, furniture, tapestry, paintings, paper hangings, and all painted, carved, and sculptured decorations; painted, stained, and embossed glass; metallic castings, wrought-iron, &c; marbles, mosaic, fountains, and vases; ornamental glass; and many other emblems of the works of art.

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 March 29.

655. H. Remond, Canger, jzs., and G. W. Lewis, Jersey—Improvements in portable dwellings and vehicles for travellers or emigrants.

Dated March 24.

656. J. Joyce, Northampton—Manufacture of pulp from twitch or couch grass.

Dated March 23.

657. J. Woodward, Acton-street—Apparatus for stopping shot and other holes in ships and vessels.

Dated March 18.

658. H. Giogiono, Springfield Beach Works, Selford—Improvements in bleaching linen fabrics.

Dated March 15.

659. R. Frauds, West Strand—Improvements in machinery for crushing, grinding, etching, glass, and other materials containing gold or silver.

Dated March 12.

660. F. Chamion and A. Meyjilce, Chalcey, France—Improvements in bleaching or printing linen.

Dated March 9.

661. R. Eowland and J. Rowland, Manchester—Improvements in the manufacture of certain metallic springs.

Dated March 5.

662. C. Barlow, Chancery-lane—Improvements in the permanent way of railways. (A communication.)

Dated March 11.


Dated March 7.

664. A. D. Brown, Glasgow—Improvements in beds, couches, and other articles of furniture.

Dated March 4.


Dated March 4.

666. A. A. Beghin, Hay, Cambridge—Improvements applicable in exhibiting artificial, natural, or other objects, on a large scale.

Dated March 4.

667. A. V. Newton, Chancery-lane—Improved mode of manufacturing carpenter or cabinet-makers' tools.

Dated March 3.

668. F. S. Thomas, Oswestry, and Hook and Sell—Improvements in locomotive carriages.

Dated March 3.


Dated March 3.


Dated March 3.

671. W. Johnson, Lincoln's-inn-fields—Improvements in the treatment or reduction of metallic ores and salts.

Dated March 3.

672. W. Smith, Wiltshire, Oxford—Improved mop.

Dated March 3.

673. W. Kestol, Borrowdale, Berks—Improvement in fixing or cementing glass to metal frames.

Dated March 3.

674. T. Scott, Brighton—Improvements in machinery for propelling vessels by steam.

Dated March 3.

675. W. J. Smith, Baldwins—Improvements in machinery for preparing and spinning wool and other fibrous substances.

Dated March 3.

676. T. P. A. Hobson, Castle-street, Holborn—Application of electricity for fixed or portable steam and gas engines to military and industrial purposes.

Dated March 3.


Dated March 3.

678. R. E. Hodges, Southamptone, Essex—Improvements in connecting wheels, drums, cylinders, and pulleys with their axes, cases, and the parts thereof one with the other.

Dated March 3.

679. W. Geessig, Widnese, Lancaster—Improvements in the manufacture of certain kinds of soap.

Dated March 3.

680. W. Robertson, Greatover-street—Improvements in producing ornamental and figured surfaces, and surfaces for printing from, also the hardening or preparing of objects to be employed in architectural subjects.

Dated March 3.

681. C. Walker, Burly, Leicester—Improvements in steam-engines, and in apparatus applicable to safety-valves for steam-boilers.

Dated March 3.

682. J. Gurney, Bradford, York—Improvements in machinery or apparatus for spinning wool and other fibrous materials.

Dated March 3.

683. J. Higgins, Manchester—Improvements in the mode or method of separating metals from each other when in conjunction, and in obtaining useful products therefrom.

Dated March 3.

684. J. Swartby, Bexarden, Lancaster—Improvements in steam-boilers.

Dated March 3.

685. G. Ross, Liverpool—Improvements in breech-loading fire-arms.

Dated March 3.

686. H. Soeholm, Bradford, York—Improvements in preparing and combing wool, woolen, and worsted, with or without descaling the same.

Dated March 3.


Dated March 3.

688. B. Sanmurz, Banbury, Oxford—Improvements in machinery for cutting turnips with revolving vegetable splinters.

Dated March 3.

689. E. Bruce, Low Mill-house, St. Bees, and F. S. Horum, St. John Beckenham, Canterbury—Improvements in machinery for making and employing the same.

Dated March 3.

690. R. Y. D. Scott, Queen's-terrace, Woolwich—Improved mode of manufacturing cement.

Dated March 3.

691. A. V. Newton, Chancery-lane—Improved machinery for raking and feeding furnaces. (A communication.)

Dated March 3.

692. F. G. Lapoulllet, Brussels—Improved apparatus for generating heat by the combustion of bituminous or resinous substances. (A communication.)

Dated March 3.

693. J. E. McLennan, Wolverton, Buckingham—Improvements in wheels, axle-boxes, and brakes for railway carriages.

Dated March 3.


Dated March 3.

695. J. W. Gross, Norwood—Improvements in transmitting and applying motive power from a working railway to passing vessels, and vessels, and for other useful and mechanical purposes.

Dated March 3.

696. J. Smith, St. Leonard's-on-Sea, Sussex—Improvements in the construction of railways.

Dated March 3.

697. W. G. Croag, Newport, Monmouthshire—Improved mode of making communications between the commander and the engineer or the helmsman, or other person on the ship-board.
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 semi-rounded iron roof. All the external boundaries will be formed round the interior. White brick, with Cané 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 magnificent 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, the current design is here most agreeably varied by the addition of two transverse, 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, profiling by the only redeeming feature (in point of design) which the Great Exhibition structure presented; one, by-the-by, not included in the original scheme, but suggested by an architect during the progress of erection.

It is 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 inaugural 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 in this latter department in which we, as architects, are most interested, and to this we owe 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 embedded.

Pain would it linger while on the threshold, to gaze over the paterae at our feet, so beautifully diversified by wood and water,—rain 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 6,—its ingenious construction,—its brilliant coloration,—the admirable ventilation 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 courts, the central building and great transept being devoted to a promenade, which is terminated at each of the extreme transents 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 western 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 praetorium, 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 forms for elegant basins surrounding the central area. Cubicula, bed chambers (little, dark apartments), and the aula, 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 of this, a passage, the walls of which are adorned with 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 arabesque lower painted almost dark green 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 Ionia, the lower part of the shaft plain, and coloured deep red, the remainder fluted, and inferior; the whole standing on a low pedestal or socle panel. 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 Meares, Cockrell, Gell, Masius, Donaldson, Hayes, and Zahn, we are indebted for all the practical considerations connected with this building. Retracing our steps into the nave, we next enter the Sheffield Court, exchanging the marble and tesserae 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 of painted 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 gallery, which are (as we believe) built up, and 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 facade 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 this case, instead of a promenade, the wall is covered with panels of enamelled slate (having heavy bronze Corinthian capitals, and shallow, tiny 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 walls is quite tamed, rather too straight, as if it pleased 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 alternate figures of flowers and fruit. The wall 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 Stationary Court presents at first 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 enclosures, however, though architectural rules are little attended to, a species of Cinquecento ornamentation is used with good effect. The tone of the colour is more sombre, while more vastness, while more massive, while 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 (cist from the immense granite ones in the British Museum), and see before us the outer walls and columns of a temple, against which are signed the names of the workmen who constructed the Great Temple of Amon at Karnac. 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 1600 B.C. The original is cut in the solid chain of rocks, bordering on the Nile. Following on, we come to the second colonnade beneath it, consisting of massive shafts, so closely planted that one can scarce breathe 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 purposes, where 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 aestheticism of an stern hierarchic religion. Yet, says Mr. Agnew, in his instructive-interpretive hand, 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 through one thousand years ago!
When the Mammoset was in all its glory,
And it had not begun to grow.
These ancient piles, now monuments stupendous,
Of which the very ruins are tremendous!"

The Greek Court.—From Egypt to Greece the transition is easy. 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. Sufficient 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, decorated by three openings leading 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 triple entablature usual in this style, the whole 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 ( agora), 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 statues’ 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 anae, giving the visitor another specimen of Doric architecture. All things, however, 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 the stones are fixed in their places. 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 how reverently must it be regarded, the окруse, or tetrastyle, objects, which we would suggest that the additions be not so numerous as to disturb the sympathetic repose which now pervades this charming spot: where the gaze may feast on raptures on the choicest monuments of art, examine their individual beauties, and 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 lately been considered too ostentatious and trivial; unless it was so 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, while the reliefs and the unrelieved division 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 Saffiebe, Giulio Romano, and Giovanni, Udi the sources, or tetrastyle. Through 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 courts, we discover, oddly enough (320), the Athenian Monument of Lystares!

The Alhambra Court, which comes next in view, presents an entirely new phase of art, and an entirely new degree of artistic feeling. It is 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 Alcarazares. This Saracenic or Moorish architecture, doubtless sprung 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 arabesques in colour, and adorned with mosaic pavements, marble fountains, and sweet smelling flowers." Studies alone were excluded by the Mahomedan law, based on religious 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 design and composition, and the legitimate successor to the Roman. The small east 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 presages a valuable addition to our knowledge of the

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, as we pass, we discover, 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 snuggly thrusted under the arched roof of the transept. Close to these is the entrance to

the Assyrian Court, constructed by Mr. Ferguson, with the aid of Mr. Layard, out of data furnished by the excavations at Nineveh. These gentlemen, it is well known, have applied themselves unceasingly to the task of illustrating a system of art of which no material evidence has been preserved in Europe, and yet, 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, the Assyrian architecture displays, in its main characteristics, enormous thick mud-brick walls, covered with painted bas-reliefs; and roofs supported internally by light columns, externally ornamented with volutes and 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-ball 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 maps to the remaining courts, beginning with

The Byzantine.—The treatment of this court, and that of the Medieval, 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 characterisation 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 Capitleo, 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 miliard-shaped, and flatly-moulded cornices, all clad in a goodly array of colours, mosaic, and variegated marbles. The capitals in this instance deserve particular attention from their beautifully-composed detail.

The central arcade is a compartment of the cloisters of St. John Lateran, at Rome (19th century), a fine example of the last medieval style. The details of the twisted column (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 Qreecum." 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 may here state in many 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 on the figures in the Byzantine doorways. May we quote a remark by Dr. Waterman, the distinguished German critic, on the subject? He refers to 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 those '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 been lost in the plaster and in the casts. This 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 head of the god." How a coating of colour would have destroyed all this sharpness, and dispersed the illusion! The era of which such decoration was annually carried is yet undecided.

Before quitting the Byzantines, let us draw attention, among other things, to the "Prioress's Doorway" at Ely; the fountain from Heisterbach, on the Rhine; the inlaid Florentine pavements; and the interesting early monuments on the floor.

The Medieval Courts, architecture and sculpture have taken a progressive step, and a collection of objects, renowned for their beauty, their variety, and their availability, for study, has been acquired, which will fall 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 (nostalgic fashion) of certain groups, made up from different sources. Thus, in the large chattering within the English court, the weatherings are gabled and finished after a recognised type; but, striving 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 Cambriaghshire church cross; and little figures have creep, cuckoo-like, into nests which it was never designed they should fill. Thus anachronisms are more or less committed, and distinctive localities cancelled; and while the experienced eye detects the innovation and is painless, those who come but occasionally would suffer a false impression. We have already touched on the subject of polychromatic decoration, which is here freely administered.

The "English Medieval courts," 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 pedal ornaments. It is modelled from the Hotel Bourgeschoude example, at Rouen (dating about 1500), or later; the open arches are of a nearly elliptic form, called Burgundian, the whole shewing 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, which, toned down by the local ornament. We have the whole crowned by a well-moulded cornice, and an unbroken attic story. Arabesques and maladilons 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 gateway of Champlieu, the two doors of the "Benediction," and many others. It would be impossible to pass without surprise at the fascination and variety of the style against those who have termed it "pejorative," and who may be better acquainted with its proper mode of treatment than we can profess to be.

The Elizabethan Festive Hall is small, and its architecture too much more than three repetitions of three arches from the exterior of Holland House (coloured, of course). The four doorways within are more attractive. Above the 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 above in globing the Renaissance facade.

This court contains several interesting monuments,—the Scotch Queen Mary, and the English Elizabeth, with the Stratford-on-Avon Shakespeare looking down upon her,—and the elegant tomb of the Countess of Richmond, by Torrigiano, the Flo
rentine artist who designed that of Henry VII, which also finds a place near.

The Italian Court, in its architecture, is borrowed from the Florentine at Rome, which was the joint work of Sangallo and Michael Angelo. Here, again, color 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 flamboyant, a taste which, with some, is akin to that of the Italian art as practised in Italy. Behind these areas is a long gallery, the ceiling of which (imitated from the library at Venice) is unusually tasteful. Copies from the productions of Raffaello, M. Angelo, Bernini, Sansovino, and others, form an interesting assemblage for study.

The Italian Festivals, as it is termed, is, like the "Elizabetian," 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 Tavera, at Milan, and a beautiful specimen it is, though very simple. The archivolt and spandrels 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 these there are not a few who won a distinguished name as arch of poets, 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 wishy. A series of arches, forming recesses, runs round each of the sides, inclosed in square compartments. The spandrels are surmounted with perforated trellace from the moulded cornices 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 only reaches the bird's eye. There is considerable invention in the general design, which may be called that of Cinquantenaire architecture; 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 spandrels of the inner screen is introduced a monogram of the architect, Moreau, Banks and Barlow. 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 art, and those 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 misappropriation by Sir Joseph Paxton. Close to these are chiselled corners, with variegated 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 stanzas to "Ode to the Passion" 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; but that the carefully designed lines of the great structure have not deviated from the original, and are doubtless the inclining, 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 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 unexamined; 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 the Crystal Palace, but it can scarcely be regarded as a new architectural property. It belongs to the first type, rather than to another original type; neither has it developed distinctive properties of its own, 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 unexcelled 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 it is very lightness, and, in a large measure, a superficial 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 stye, 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 reunions. 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.

But the winter garden of the Royal Botanic Gardens in the Regent's Park has 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 illustrates well what may be done with hot-houses. Built 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 effectually 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
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL.

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 be available to the manager 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 hand of our city 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. Online applications for special purposes will of necessity 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 comparatively 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 site might be obtained. The design of the structure, of course, will depend on the situation in which is placed, be it that of a country house, or the design for Battersea Park, pointed out the artistic effect producible from the elevation of such a building on the river side casting its shadows and its reflected lights on the glistening waters. A structure of this class, with a score or more on a river, is not well adapted for producing the picturesque effect. There are likewise situations on level ground, amidst trees or park-lik 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 sufficiently lead to different modifications of 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 medieval cathedral is scarcely more distinctive than a crystal palace; they are each works of a special class, having differences new or different in style. The material employed, arranged to a greater or less extent in sheets, produces a uniformity and entirety of arrangement, such as would be the case in a single-leaf book. This results in a 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 surfaces give 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: Chapels, and be altogether without reposes. It is possible, however, that at a future time, by the use of coloured glass, polychromatic effects, both exterior and interior, may be obtained, contributing to those of ordinary polychromatic decorations, though, we expect, not in the same manner. But it must be noticed that, for the sake of the picturesque, and in the absence of a material which can be varied, as in architecture, the changes of form and substance, contribute so highly to effect, not do, 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 will be the value of the subject. There are more and more monuments, as works of art, to be seen in large cities, and the beauty of the beauty of large buildings, in such cases, will, we believe, be generally recognised. The city of Paris, with its vast population, is a fine example of this. The Crystal Palace exploits this in a high degree, and we are confident that it will be of great service to the whole of the world. The designer of an altar-piece—say, even of a cabinet picture. After all, there are more painters known to the world than are sculptors, perhaps—perhaps many sculptors as there are architects whose names are in the mouths of the many. What is the object of sculpture, in art? To adorn the temple, or adorn the altar; and it 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 design is not by the last, but the present, so that the public know it not. Hence, too, the ambition of the architect is easily cramped; he may design palaces and cathedrals as he likes, but the public will have a lot if it be his to execute one. In fact, he has to limit his ambition, and content himself happy if he be connected 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 elevation of the building and the favourability of the public. Many of the large structures we have had of late have been those which have had the least pretensions to art—warehouses, factories, and railroad-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 painter, bears no comparison 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 sought for it. By giving the architect better opportunities for the realisation of his ideas, it shall give him a larger scope for 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 heretofore it was an occasion for exertion which 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 reception of all the fine arts, and that the whole world has been. 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, 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. Instruction as an infant school is better adapted for a taste 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 thoughts; the subject must be laid before them in something like connected form, and mere facts made up by hypothesis. The British Museum, again, cultivates archeologists 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 those of art, the institutions would be connected, and the 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 what they can acquire by lectures, is connected with medieval buildings in their integrity or 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 a great school of architectural study. We care now not whether the architecture shall be Roman, or Egyptian, or Gothic, or Pompeian, or Theban, 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 tableaux 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 the most favourable and well-authenticated examples, the data for a further study, which will often be specially applied by the artist 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.]

Is 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 enough; and new works should be such as would be to 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. The land is well supplied with springs, 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 as 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 confusus and animalcula. 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.

If 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 limit of aqueduct main will contour the land as far as possible. Valley conduits may be employed by large farms. They can be made uniform in any given gradient; 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.
siterate 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 Clydech 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 earthware pipe may be employed for complete conduits 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 Clydech for collecting springs, &c., need not cost more than four thousand pounds, being mostly in the whole, for collecting the water and conveying it to Swansea, 10,000l.

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 £2,500. Add for land compensation, engineering, incidental expenses, and other contingencies, 10,000l, and the sum will be as under:

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Works on the Clydech</td>
<td>4,000</td>
</tr>
<tr>
<td>Aqueduct Main to Swansea</td>
<td>6,000</td>
</tr>
<tr>
<td>Plant within the Town, Service Reservoirs</td>
<td>22,500</td>
</tr>
<tr>
<td>Compensation, land, engineering, and incidental expenses and contingencies</td>
<td>10,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£42,500</strong></td>
</tr>
</tbody>
</table>

Mr. Scott estimates that the cost of water works (for an increased population of 55,000) would be as under:

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Works on the Western District</td>
<td>91,000</td>
</tr>
<tr>
<td>Works on the Carmarthenshire District</td>
<td>55,000</td>
</tr>
</tbody>
</table>

The works, as projected for the Clydech 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 the 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 £5,000.

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, or less, present, and cholera has prevailed to as great an extent as on the loath, flat, and excessively damp. The same remarks apply with equal force to Plymouth, Dover, Yarmouth, 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 its 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 Briston and Wolverhampton, in all of which places there has been cholera.

Falmouth, indebted 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 cesspools, 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 cesspools. The same result may be attained by sanitary works or regulations is to secure pure air.

The gross estimated rental of the town is 7500l. 4s., and the rateable value thereof is 6875l. 2s. 4d. 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 in some spots of ten times the area of the whole of the town, and very large bodies of water are protected by high lands, so that to be a safe haven for shipping. Average spring tides rise 18 feet, at 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 9000 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 being by turns the limits of the houses; the breadth of 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 directly to the annoyance and sickness 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 has made some improvements since 1848, but finding the most active measures ineffectual, 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 collieries 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 kilsim (the local name for clay slate), granite forming the surface inland, rising at Carm Menells to 820 feet above the sea. The shores of Falmouth harbour, which are principally moles and clay slate, rise some 900 and 300 feet above the sea. Dykes, veins, and "lodges" 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; but the drains disgorge a mixture of rubbish with slate bottoms, and empty themselves into the sea. The length of highway or streets, within the corporate district, is 3029 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 one-sided middens should be removed by a 600 feet 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 matters, liable to decomposition, be set aside, covered and inclosed in 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 be removed from the streets, and sewers and drains carried on the surface.

The sources of the supply of water to the Falmouth district are certain springs and streams at Kegilhill and part of the College river. The reservoirs is situated at an elevation of 178 feet above high-water mark of spring tides, and calculated to contain 178,400 cubic feet of water; from this reservoir a 4-inch main is carried to the market street, a distance of two miles, from whence the water is disseminated throughout the town. The cost of the
STONWARE DRAIN-PIPES WITH WEDGEULAR JOINTS.

ROVERE, PATENTS, October 21, 1853.

FIG. 1. FIG. 2.

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, and is connected 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 sphynx, 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 flange about one inch wide, which answers the double purpose of holding it to its place, and making a tight joint between the flange 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 that of the damper, the lever will be horizontal, thereby closing the damper; of course, if the pressure now diminishes a little, the weight and lever will descend and open the damper.
FILTRATION OF WATER.

By S. Trottman, Hydraulic Engineer.

The steady, unmistakable 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-ruled providence to the lessening of the fatal influence of this fearful visitation.

The most prominent sanitary ligus fatuum 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 propose 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 embodiements 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 quod non that all apparatus for filtration should be rather repellant 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 filter-
ing 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 as to make 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 purifica-
tion of that water by chemical agency, so as to deprive it of its poisonous constituents, as well as to render it absolutely pure. The result is, 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-
tive gallons to each individual. Now, if we analyse the mode of contamination, we shall find that the rain, which composes the chief water supply, being filtered, the next arises from repre- sents 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 pro-
portion is run to waste, we cannot hold the companies responsible for the delivery of the water in a pristine state. Taking a pe-
culiar view of the question, the principal millions of pounds 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 of this 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 result; and we conceive that the question is only to be met by the public provision for individual establishments the necessary appara-
ratus 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, and that the impurities of the water run through levels 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 zoophytes tribes, which is alone sufficient to condemn any such medium. The various methods now employed for the purifica-
tion of water may be classed under three heads—mechanical, such as straining, usually termed filtering; chemical means artificially applied, such as antisceptic media, of which animal charcoal is by far the most effective; natural chemical means, such as oxidation or, better, the preponderance of one chemical combination oxidising and precipitating the impurities. One of the methods employed for defeating 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 infinitely small in contact with the oxygen of the atmosphere. The mode of purify-
ing 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 appar-
atus 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 objects, left to itself, will purify the water, and that the apparatus shall not become charged with the impurities of the preceding impurities.

It needs no stretch of mental exertion to comprehend the fact that the most perfect medium of filtration may be rendered useless by the most trifling adaptation, leaving for this condemnation, 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 liable to occur with its effectiveness. The 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 descent, 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 course or on clean water finds its way through the medium, all 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, leaving behind all gross impurities; the move 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 descent, principle, assists the medium to permeate the impurities, from the decomposing 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 scaverno No. 1, holding back the larger or grosser particles. Next a stratum of a less porous character, that will permit the impurities of the second-sized calibre are retained by scaverno No. 2. The infinitesimal impurities are now supposed to be held back by a yet more dense and compact medium, performing the duty of scaverno No. 3. We have now to deal with the subtle combina-
tion 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 scaverno No. 4. Now comes the question, how do these four scaverners cure or cleanse the water? We answer, the art is lost! 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 presen-
cence 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 suggestive of the condemnatory effects of mal-adaptation; for, admitting that the impurities are all removed, why, after all, 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 mate-
rial in any way to reduce its daily yield. And more fully 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 descent, 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 tempertature—such apparatus also filling themselves, yielding a far larger amount of water, and of a quality far superior. 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. Among other things, it is brought 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.

[Continued from page 303.]

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 innocuous, stating that the sewage, being lighter than the main body of surface water, was deposited at ebb-tide on the shore. But although this matter was offensive, it was valuable as a fertilizing agent. Various schemes had been proposed for recovering the manures, but had not succeeded as commercial speculations. He further stated, that at the present time Mr. Wickstead, Engineer to the East London Waterworks, was engaged in a very large scale of speculating 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 fertilizing the country. If this were the right principle, it was obvious that the same should be 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 undesirable. Further, as those plans proposed to make the Thames the receptacle of the sewage, both of the principles laid down by Lord Palmerston would be violated.

Mr. Moxewood, representing the Great London Drainage Company, stated, that the question before the meeting was the “outfall” for the drainage of 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 other street. In Vanwall, some respects, this street, the Board of Health had found 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. Keay, the late Surveyor, had been able to show that 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 people will be destroyed.” In reference to reducing the actual sizes of house drains to 19 and 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 obstruction of 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 clay and sand, and 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 inadmissible. 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 prevent their effluvium. 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 the houses on Fleet-street, would be so 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 a temporary lower outfall caused by the removal of old London Bridge; and in 1847 Mr. Wm. Hoaking, 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. Moxewood described as being accomplished 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 run under the roadway of Great 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 then thrown on the top of the hill. 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 the 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. Moxewood 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 Lee,” and that on the south side as a “system of sewers between a point near the top of Woolwich Road and Blackheath in Vanwall, the tunnel sewage 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 of the City Metropolitan Commission (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 re-consideration that the tunnel sewers were intended for Richmond and Croydon: that evaporation amounted to 32 inches when the rainfall was 47 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 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 decelerating of sewage was as follows: when related 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 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 salable 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 stated that the case of London had been the same case in the commencement of their operations, the main was afterwards laid into the wall. Mr. Burnell had been misinformed; in 1853, 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 long distances, 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 waste.

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 said that the choice had been made 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 manufacturing establishments might be made to pay for the cost of the recovery of their sewage, with the aid of the bays. 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 of sewage, he had no doubts of its advantages, but questioned whether it could be made to pay. The magnitude of the drainage of London (excluding rain, 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 sewage, therefore, is one which manufacturers complained of in 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. Mesers. 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 enormous paramounting agent 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 faecal matter of the twenty-four hours, if collected, and much of the effluvium which arose at low water. There was no 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 80,000,000 bushels 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 placers 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 small would be lost in two minutes and a-half.

Mr. Arnot produced a drawing of his proposed plan of sewage, 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, providing 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 Macin, to whom it is generally ascribed, and that his (Mr. Garling) 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 number of the former was believed to be altogether adequate to provide for the ordinary rainfall in the metropolis. After some further unimportant discussion relative to gips sewers, the question was brought to a close.

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. H. 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, Bates, 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 employed in the engineering department, and 193 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 company has the right of way for its own purposes 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 spread 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 216 feet long by 48 feet wide, and one span of 155 feet has already been shipped. There is a 32-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 putting 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 between the narrow and broad gauges in width—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 8 feet diameter, and the leading wheels 3 ft. 6 in. diameter. The engine is tubular, having 175 square inches of heating surface, 14 inch diameter, with 78 square inches of heating surface. In the fire-box the heating surface is equal to 78 superficial feet; making a total of 850 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 chimney, 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.

4 The proposition of Mr. Atkinson is in most respects identical with that of Mr. John Wickham. However, the device invented by Messrs. Bute and John Wickham in 1829, but as already stated, was rather crude and unpractical than that of Messrs. Bute and John Wickham.
ERRIS FISHING SETTLEMENT, MAYO, IRELAND.

T. C. Tinkler, Esq., Architect.

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 1st 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 now to say that, owing to the very rapid 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 unfinished. During the past fortnight, however, Mr. Dargan, the eminent contractor, has employed a very large building 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 works 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 Moge masks, accompanied by your resident engineer, the result of my examination of 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 present 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 tending 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 Committee of 20th 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 trellis, more particularly as he expected at the time that the structure was then near a point of rest, but the opinion that, if the insertion of additional metal 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 trellis I estimate at about 100L. 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 trellis perform as just described. 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 in a very good state of 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 31st, 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 Jarr, 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 the Commissioners of Sewers, on the
Sewage of St. Thomas's and Exeter, &c., the Commissioners
have considered it advisable to send you the reports
relating to the examination of the systems recommended by the Board of
Health, which 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. G. 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 opinion which might, without
examination, 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 pipe 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 are more stored up; pipes
are more 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 sewerage 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 sewerage of
the higher towns must be conveyed through the lower towns,
and in the consequence the sewers of the latter, beyond their own
special requirements. I will here give the population of the five
places particularly in question:—

<table>
<thead>
<tr>
<th>Town</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tottenham</td>
<td>11,000</td>
</tr>
<tr>
<td>Rugby</td>
<td>8,000</td>
</tr>
</tbody>
</table>

* See Journal, ante pp. 126, 177.

St. Thomas's, Exeter, excluding Exwick, whose drainage is entirely distinct...
Bernard Castle.................................................4,000
Sandgate, being an addition 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 is the works of any considerable extent. It has taken 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.

Advancing now to Mr. Ward's letter, of which I append a copy
for the convenience of reference,* the general assertions it con-
tains require to be dissected; and then they will be found to represent
nothing 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-distinct from house-drainage. Now, without asserting that the Board of Health leave surface drain-

* See Journal, ante p. 126.
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 6-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 common sewer there is a pipe for receiving the discharge 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 great distance from the water-shed line, must exceed the capability of pipes, and, consequently, it must therefor 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 system of the Board of Health system either entirely overlook or make light of the 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-cleaning" and self-repairing, so as to render it unnecessary for men ever to enter them, then the question of size becomes simply an hydraulic matter. Does the sewer-works of London.

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 served by the additional section of the Great Intersecting Sewer, recently designed by the Engineers of the Corporation, 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 latter of the unmitigated sewerage which escapes them. The 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 3,000,000l. 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 of Mr. Bazalgette, but have been led, instead, by the advice of Mr. C.F. C., who, being so well-versed in the art of the Science, 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 the metropolis; 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, indeed, the Commissioners, in a very large number of instances, have, indeed generally, to make the sewers larger than purely hydraulic considerations would require; and that is the necessity of 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 con-
that they be of a capacity sufficient for a man to enter. That the advocates of the exclusive use of small pipe sewers are unconsciously, as the true importance of the larger ones 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 the combined back drainage assumes a very subordinate place in the south. In fact, 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 save the important sewers already laid. 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 building owners, 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 suspicion 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 Sandwich it has been generally discontinued. 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 slighest manner that the law will permit, with a view to get them off the market as fast as they can. The want of a separate drain is a 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. Again, it is contended that the cost of the separate system is very small; the cost of the combined mode would be the cost of the separate mode as 1 to about 1½, 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 which actually do depend upon the local state of the law. 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 entire area. The combined system 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 basements or cellars, and it is not exposed to flooding for want of a drain in front. It is true that in that case it is 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 central point, should the houses require the cross spreading of the sides. The advantage 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 short cross pipes. 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.

The system has not been made to appear at least probable that the alleged great superiority, in point of cleanliness, 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 generally reported.

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 said that the question, as that of the drain itself, is more a moral than a physical 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 unable to withstand 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 streets and alleys.

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 which 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 streets and alleys.

Neither can the Commissioners acquiesce in the expenditure 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 30-inch pipe breaks. The Commissioners have, however, 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 admirable; 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 rules for the general drain of the city. The Commissioners have no authority, or power, or discretion to which they were not 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 which 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 streets and alleys.

Neither can the Commissioners acquiesce in the expenditure 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 30-inch pipe breaks. The Commissioners have, however, 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 admirable; 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 rules for the general drain of the city. The Commissioners have no authority, or power, or discretion to which they were not 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 which 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 streets and alleys.

Neither can the Commissioners acquiesce in the expenditure 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 30-inch pipe breaks. The Commissioners have, however, 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 admirable; 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 rules for the general drain of the city. The Commissioners have no authority, or power, or discretion to which they were not 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 which 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 streets and alleys.

Neither can the Commissioners acquiesce in the expenditure 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 30-inch pipe breaks. The Commissioners have, however, 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 admirable; 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 rules for the general drain of the city. The Commissioners have no authority, or power, or discretion to which they were not 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 which 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 streets and alleys.
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 made, the house, drying-rooms, and other works of the company, having succeeded in inducing the manufacturers to make them of good material, and well burnt, 14 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. Basaigette's Report on the failure of pipes in the Metropolises, 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. 1068, being the further Report of Mr. Austin, on the Chorlton Drains, 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 securing power. The Commissioners point out that the whole house drain pipe, over which the whole accumulation of the liquid passes, is liable to clogging, and whilst the loss of securing power is practically insignificant, the 6-inch pipes allow more readily the passage of those innumerable substances which are so often "improperly admitted," and which will continue to be improperly admitted by careless pipes, without disturbing the sanitary machinery. 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 6-inch pipes was largely enforced in the Metropolis by the then Commissioners, often against the urgent remonstrances of the house owners. In many instances these 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 the Commissioners; 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 approximate estimate of the relative value of the systems under discussion.


**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 down the word on the book at which the 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, where the washer stands at washing, and the other 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 above and below, on the 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 diseases, and have connected with them a drying-closet C. For the general purposes of house, drying-rooms, and iron work, the building is 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.

Each washing compartment contains a wash-tub and a circular steam or boiling tub, each supplied with cold water and steam feed. D, D, D, a brass plug in the bottom of each tub conveys the waste water to the drains. In addition to these tubs, E, some of the compartments around the walls have a dolly-tub, a favourite system of washing in this part of the country.

The whole machinery is fitted with Kirkwood's common closets. The working machinery of the establishment is contained only in the whole house-stripe over, on the side, within the external walls is carried by a system of groined arches on brick pillars 18 inches square. The unconfined and uninterupted working of the whole apparatus is thus obtained, with a steady means of access to the drain and water and steam-pipes entering the compartments of machinery. D, D, D, are 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 front. To prevent want of light in the 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 fire. 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 spandrels of the arches to the external air. Near the roof and along the front and one side of the building are semi-circular 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, steps and landing. The roofing is of great stone. The roof and glass are fitted in with galvanised iron louvres, made to open and shut by cords from the gallery. The whole of the iron work and iron fittings and iron ornament 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 work 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 KEYHOM DOCKS.

By Samuel Clingo, Esq.

[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 illuminate 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 the principles of mechanics only on a very small scale, but which have been practically applied to such purposes, and his best energies are in consequence enlisted;—to sea-tol 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 accommodate.

All machinery and contrivances connected with docks are of positively recent origin. The changes that have taken place for the good of the community are enormous. London had then no docks,—may not we ask what could our trade have been then, 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 which many of them have thrown in the way when repairs had to be done? London, I say, at that period, was not so much a port as a country town, had no docks, unless we except one at Blackwall, and the Greenhund 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, 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 places, has been the last to try the experiment of docks. Notwithstanding the total inadequacy of legal quays, which subjected the merchants to innumerable 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 private and public 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 Pool were the first of the kind that were constructed in this kingdom, by virtue of an Act of Parliament passed in 1706. 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 develop 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 them are the same as those allowing those of a smaller size, and the current of the tides fluctuating up to three times as much as it does in mid-river, the entire force of the tides is equivalent to three times that of the summer months. It also appears that the greatest result as yet obtained is 6000 lb. per square foot; but those experiments have not been continued long enough, nor as yet applied to a sufficient variety of places, to give us any certain information available for 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 present practice.

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 8 feet thick and about
40 feet long, weighing nearly 300 tons, was, at Fletar 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, and perhaps considerably upon the Pymoor, where the
water may, therefore, be considered quite a navigable river; 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.

Weiss told, that during the storm of November 1824, a length of
796 feet of the 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
stone 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 Chelten beach, some 300 yards wide
and 150 yards long, 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 concomitants they are liable to,
from portion of wreck being driven against them, and from the
vessels entering the first line of water containing.

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
easily become dry by the ebbs of the tide, when the gates are
left open, and 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
flootation had to be got at by creaking the ship over; and if this
defect happened to be near the line of the keel, the force required
to be exerted to have the vessel down "kiss 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.

The water would be accumulated in the dock, and 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 height of pumping, a cubic foot of water from a depth of 30 ft. in
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 gives great facility for repairing ships, for
after the dock-gates are closed, a valve can be opened, and the
water let out very quickly into the sea through a subterranean
culvert, leaving the ship high and dry. I trust that Admiral
Dunlay will do as little damage as may be to these docks, for we
shall find the importance of them as a general basis for
the

This arrangement gives 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
Dunlay will do as little damage as may be to these docks, for we
shall find the importance of them as a general basis for

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
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
density times the depth of its 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
are together equal to the weight of water displaced 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 case 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
caisson, and lifting them out of their seats. Its pressure side-
ways, or its horizontal pressure, may be illustrated by taking
a tube bent like the letter U, and putting a vertical diaphragm
in the tube at the lower part of the tube, and allowing water to be
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 due to the
water in the first limb. It is the same with a body being
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 square
of the depth of the immersed gate. A gate 30 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 weight of pressure in
pounds, the square of the immersed depth must be multiplied by
265 + 2, or 3125 lb. Thus the total pressure upon each foot in
width of a gate 30 feet deep will be 2650 = 400 x 3125, 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 lying between the upper part 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 the action of water and waves, and to the pressure 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
elastic repair works.

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 a depth of 30 feet, I think we should be enabled to
adapt 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. Samp
to the Keyham Dockyard, these objections do not exist; but then
there must be space enough in the thickness of the wall dividing

34*
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 sodden barge. Secondly, their gates are more frequently in need of repairs; and if they are cast, 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 these gates, 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 miter posts will prevent them from meeting with that precision absolutely essential to prevent leakage. To obviate the 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 35 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 necessarily 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 the purpose of a scaffold during the construction of the London Docks. A collier was cut down, and a scaffold 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 first applied to the construction of a floating vessel for a gate that General Sir S. Bentham took his idea of the construction of the channel. 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 gate available. This provision necessitates a departure from the perfect form of wall and invert, which, on bad foundations, may be a source of defect—a very serious one, it is true, 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 floatation, at the lowest state of the tide at which it is likely to be moved, will keep the keel clear of the principal obstructions. The sliding-gate is a defect—a very serious one, it is true, since extra material must be used to gain equal strength at every part of the caisson. It is a matter of common experience that if a caisson has to be removed, that the tide may ebb and flow within it; because if it did not so, as a matter of course, it would lift the gate, the line of floatation with the same weight remaining constant in the same vessel. To remove the caisson, the water on one side of it must be suffered to become equal to the 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, since, if 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 ground, when it is towed or hauled away clear of the dock entrance, and, allow of the vessel passing 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 86 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 100 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 1 inch at the rail of the upper deck. The plates forming the sides diminish from 6 inches to 1 inch thick, the bulwarks being 1 inch thick. Next the bottom is the keel-plate, 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 neighborhood. A lining of indiarubber, 6 inches wide and 1 inch thick, was fastened to the outer surface of the keel and stems, with counter-sunk 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. The caisson was made to last as well as long as it lasted, but it got destroyed by abrasion, and oak plank was substituted. This caisson cost in America about £15,000.(at least so it is stated in General Searl'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 wide, cost only about £10,000.

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 machinery 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 as they are removed, viz. it is truly a sliding-gate, by turning it and floating it dry 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 by means of a high-water wall 11 feet high, and of a pressure of about 1700 tons, arising from the entire depth of water at spring tides, which is about 36 feet or 38 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, and all the parts left out to the highest degree of excellence, and the result of the work was a work of great excellence in 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 water, and prepared for its use on the upper side, are left out to the highest degree of excellence; and the whole of the bottom or hold is formed into a perfectly tight air-chamber, constituting what Mr. Fairbairn terms the 'trunk' 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
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 permanent admission at 68 ft. 8 in. at the bottom, and from the tide, thus neutralizing the buoyant principle of the sills. 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. The large pipe, 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. The effect of the current, 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 haulin-chains, and are wound upon drums in the south recess. In order to remove the caisson from its position (assuming the entrance of water into the ground) and to draw it from the chamber, the entire length 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 pins, the hauling gear is then detached from the tightening drums by sliding clutches, which are fitted in 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 fill the caisson (which hitherto has rested upon the bottom), and this is accomplished by opening a valve 12 inches in diameter in the bottom of the upper water or ballast chamber, and admitting 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 side-valves, or by allowing the free working of the flap-valves on the back of the sliding clutches. The latter is done by raising the valve 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 side 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-tanks are 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 30 tons. The only peculiarity requiring further to be explained is this. Supposing the caisson to be ballasted at 3 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 right-hand side, being equal to 30 tons; if the ends 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 rests 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 men-
tioned, the length of the caisson at the top is 83 ft. 6 in. and at the bottom 68 ft. 6 in., the height being 43 feet exclusive of the falling handrail; the masonry of the entrance is 90 feet wide at the top, and 68 ft. 6 in. at the bottom, so that the entrance has an overlap on each side of 1 ft. 3 in. at the top, and 1 ft. 6 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 flaps, and fixed in the mud-brick wall 8 inches thick, to make the water as 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 18 inches at the beam, or 14 ft. 10 in. high. 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 5 in. thick at the bottom, gradually increasing to 3½ in. at the top. The side plates project 18 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 any movement from cracks or joints of those parts. Along the bottom the cross beams are not so close as those up the ends, in order to insert strong wooden knees 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 simply that required for a curved caisson—have powerful stringer-plates 3 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 3½ inch; with 38 ft. 4 in. of water it was 3 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. Scampl'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 caiions of the old construction, when pumping is necessary, is objectionable by reason of the time and labour necessary to be expended in the admission of docking water, and that, by means of modern methods, the same may perhaps be lost. That, under ordinary circumstances, where economy is a consideration (and when it is not!), and where dock entrances of large size have to be closed, and also where the position would not impede the floating of it away, Mr. Scampl's "selfacting" 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 causes of great delay in the working of ordinary caiions 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.

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 outsidethis, and the lock dry, is at all times perfectly water-tight. The operation of working is performed by a few men only at a casement, and it can be taken out across the entrance, back again into the chamber, 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 chamber.

The gravity 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 in the working 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 arrangement, 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 a point, and additional water being added 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 sluices-doors below the water-line; the doors are then opened, and the water will flow in, and the caisson will continue to sink; the value of the tank is let out.

For lifting the caisson, the sluice on one 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 of the whole has been emptied, and the sluices are above the water-line, and the tidal-deck will be free; the sluice doors are closed, and the caisson is perfectly under control. During the operations of sinking and lifting the caisson, care is required to guide the steam 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-trunk; and when it is required to lift the caisson, the valve below is opened, the water escapes, and the caisson floats.

The dispatch 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.

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, 1834, 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; 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. Forbush. Mr. Scamp, on being asked by the Admiralty to add a feather to the rich plumage 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 in 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 by the Admiralty, the caisson built accordingly, and put into its place in the opening of the basin 13th 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 tubes, as required by the increase or decrease in the water of the deck. This water would of itself run out of the cisterns at the time of low water, even at neap tides, by means of the panstocks or culces, as shown in the profile."

From that proposal, it is evident that no pumping was required for raising water out of Sir Samuel's caissons 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 removed by pumping alone.

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 culces, I have to say, that I have never known a caisson without such an arrangement. It is true, that in some cases the latter are entirely dispensed with; the sluices are weighted with water admitted in such a way, and that the water is let out by opening the culces. 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 mere 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-cumber 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 an investigation in this branch. I have had long experience in our principal dockyards. To inquirers 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 yard where it worked." 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 twelve minutes’ difference in sinking the canal.

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 caisson is made to fit within one another, theゾ横的 order 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 caisson, which is built much in the form of a navigable vessel,” &c. In continuation of its description, afterwards goes on to say, “the curvature given to the sides, and the same time that it affords a degree of strength by which becomes the density of the water, sufficiently considering the design of the superstructure, 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 the students for the various duties of those whom they may be called to the opportunities of material and responsible duties of the profession to which they are to be called, and to stimulate and encourage you to surround 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 continual improvement in the many incalculable benefits which are derived from a more routine discharge of their 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 and more evidence is being given that the object has not been to exclude, but to encourage and stimulate him in the direction of the most direct and efficient employment of the powers by which he is endued. It is in the most direct and efficient use of these powers that lie the secret of 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 various periods either manifestly, or 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 have always, whether direction 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 the accuracy either by mathematical calculation, or by the aid of assistants of works both of the principles of engineering practice, 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 mistakes in the first place, the correctness of which can only be ascertained by an inspection, he will always render it one which the young engineer will be liable to call 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
solidity, 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 the materials employed, as well as 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 have been brought here to show you what they already are 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 taught you to appreciate them, and familiarised you with the countless details involved in actual work.

And now, the route of our railway being determined, and the requisites worked out, it is now necessary to 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 has abstracted from them a number 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 foundation, the materials to be used in the work, the manner in which these should be prepared and combined, and the cement 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 andaccuracy will be supplied by a conscientious anxiety honestly to discharge the duties imposed upon you.

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 performance of contract. This is not the case with the engineer, 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 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 an interpreter 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 body of forces whose knowledge and experience is 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. H. Stephens truly says, to take up his position in the scale of knowledge, as the man who is the most calculating judgment of all 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 contract; the work expected to undertake, and the scale on which 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.
of iron and coal are as yet unnecessary; and a practical knowledge of Chemistry is essential, so far as will enable the architect to ascertain by analysis the properties of minerals, and of the materials requisite for the execution of the work itself. 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, designing 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 to construct in one lump, it could be undertaken, and in new colonies, where local contractors are not to be met with, and where the master 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 this kind of works the master will be obliged to some 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 to a great extent. Independence of 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 handcraft details, in the mode of shoeing, bolting, and securing framing timbers; in the bonding of brick and stone-work; in making templates 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 all such details, and learn the engineer, 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 mechanical difficulties. The difficulties of the pure and the mechanical designer. 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, mills, wind-mills, &c., &c.; and in all these cases, 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 is a discovery on the part of the mechanical engineer, to detach 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 Engineering Course.

The theory of fluid motion is in constant 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 preparing a work embodying 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, and this instruction is prepared to meet the necessities of the case, 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, I think, is indispensable to the engineer of a high degree of utility to him. These are, Chemistry, Geology, and Experimental Physics. There is no need of the last, indeed, of portions of these sciences cannot be dispensed with; and the more complete an acquaintance with them is, the more the student is at the disposal of his profession. The end result of the student desirous of 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 development of this force, which is one of the most important components of the new engines. 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

---

*Thus Rationalists are called, not because they, as distinguished from Trinitarians, do not believe in the unity of the Divine Being, but because they understand Godhead, and not in the plurality of the Persons. And again of two brothers, both equally good lawyers, it can be also a mathematician, but he will be distinguished from the latter as a theologian, and the latter as a lawyer. The fallacy consists in inferring that because a person possesses a certain quality, to the exclusion of all other qualities, therefore he possesses it to the exclusion of all other qualities. That because X equals Y only, therefore X equals Y.
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL.

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 arrangement of the boiler 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 a conduit or circulator connecting them, with the division 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 small quantity 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 is so arranged that the feed-pumps 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 at each end, located at equidistant points in the horizontal plane. The connections are, for in numbers, 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 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 arrangement of the boiler 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 a conduit or circulator connecting them, with the division 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 small quantity 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 is so arranged that the feed-pumps 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 at each end, located at equidistant points in the horizontal plane. The connections are, for in numbers, 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 boilers 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 boilers of the propeller Troy, from which the engraving is prepared, has been now more than three years in service without any expenditure for repairs.

RAILWAY SIGNALS.

BERNARD COWAN, 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.

* 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 felt, or other non-conductors, is a refinement not yet introduced to any considerable extent, either on those or other steam boilers in those localities. Under all the circumstances with the safety of the ordinary fitting 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 65 to 80 lb.; throttle-valve never used:

The Niagara, with a fire surface of 575 square feet, a grate surface of 397/4, and a cylinder 3 ft. 6 in. by 25 inches, makes 56 revolutions, cutting off at 40 lbs.—The Forest Queen, 357, cylinder 3 ft. 6 in. by 28_4 inches, makes 58 revolutions, cutting off at 40 lbs.—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 40 lbs.—The Prairie State, Michigan, and Opelnetsbuur, each presenting 100 feet of heating surface, and 384 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 40, 40, and 40 lbs.

The consumption of fuel in the furnaces of these boilers, which are termed "vertical vertical," in the Official Reports of the Inspectors, are recorded as follows:—Niagara, 4-cord of wood per hour; Forest Queen, 4-cord; Westmoreland, 1 cord; Boston, 4-cord; Prairie State, 1 cord; Michigan, 4-cord; Opelnetsbuur, 4-cord.

There are now floating on the waters of Lake Erie, eleven or more steam boats with card-tube boilers. The water-spaces adopted are uniformly 4 inches thick around the furnaces. The water-jackets are some what thinner at the base, diminishing to only about 2 inches thickness at the top. The iron is 3/4-inch thick for the principal boilers, and 4-inch for the jacket, stayed every 6 or 8 inches. Water bottles can be, and are, fitted to preserve the steam, 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 keelboilers, but gives free access to water in case of accident, and allows a quick and effective repair in less time than does a brick deck. 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, Patents, 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 other inventors have been seeking to increase the "creating" power, with a view to superseding water and steam power and animal force, such men as Babbage, Bennie, 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, especially when compared with the recent improvements in the construction of machinery and the formule 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 machinery presents 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 20,000 lb. raised the same height in the same time, or by a man walking a canal-boat, 180 to 200 lb. 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 80-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 the allowance, but when Watt fixed the steam horse-power at 33,000 lb., it was because up to his time, a loss of 46 to 50 per cent. was taken place between the practical results and the original theoretical calculations, as founded on his experiments. But this amount of 50 per cent. is not that allowed by practical usage: this the amount of an engine required to put into motion certain combinations has to be ascertained. There is friction and inertia 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 in practical combinations to the purpose. 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 invention for the purpose of preserving the energy, but not by as 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 keel-case, but gives free access to water in case of accident, and allows a quick and effective repair in less time than does a brick deck. 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, Patents, 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 other inventors have been seeking to increase the "creating" power, with a view to superseding water and steam power and animal force, such men as Babbage, Bennie, 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, especially when compared with the recent improvements in the construction of machinery and the formule 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 machinery presents 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 20,000 lb. raised the same height in the same time, or by a man walking a canal-boat, 180 to 200 lb. 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

* See Dr. Ure's 'Philosophy of Manufacture.'
motion and their inertia 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 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 wheel is in most cases reversed by, firstly, substituting curved instead of straight or polygonal buckets, differing from the curved shapes introduced of late by Pontelet, 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. 3, 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 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 greatest 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 a-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. Proceed 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 E 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 B, and with radius A S cut the semicircle at T; draw T U...
perpendicular to AC; then AU is the root required, and true to the right 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 AB less than \( \frac{1}{3} \) AC. The method described gives

\[ AU = AC \times AB \]

and we have also,

\[ AT = AC \times AB \]

which will apply when the square side is the longer of the two.

Table to prove that the Method described gives a very slight Approximation to the True Root.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>1</td>
<td>2</td>
<td>19</td>
<td>2.7171</td>
</tr>
<tr>
<td>80</td>
<td>2</td>
<td>8</td>
<td>79</td>
<td>4.1089</td>
</tr>
<tr>
<td>180</td>
<td>3</td>
<td>18</td>
<td>177</td>
<td>5.6863</td>
</tr>
<tr>
<td>320</td>
<td>4</td>
<td>32</td>
<td>31</td>
<td>7.3939</td>
</tr>
<tr>
<td>500</td>
<td>5</td>
<td>50</td>
<td>49</td>
<td>9.2370</td>
</tr>
<tr>
<td>730</td>
<td>6</td>
<td>73</td>
<td>70</td>
<td>11.1407</td>
</tr>
<tr>
<td>980</td>
<td>7</td>
<td>98</td>
<td>94</td>
<td>13.0282</td>
</tr>
<tr>
<td>1250</td>
<td>8</td>
<td>125</td>
<td>117</td>
<td>14.9277</td>
</tr>
<tr>
<td>1520</td>
<td>9</td>
<td>152</td>
<td>131</td>
<td>16.8777</td>
</tr>
<tr>
<td>1800</td>
<td>10</td>
<td>180</td>
<td>160</td>
<td>18.8792</td>
</tr>
<tr>
<td>2420</td>
<td>11</td>
<td>242</td>
<td>206</td>
<td>22.9292</td>
</tr>
<tr>
<td>2890</td>
<td>12</td>
<td>289</td>
<td>233</td>
<td>25.8233</td>
</tr>
<tr>
<td>3390</td>
<td>13</td>
<td>339</td>
<td>271</td>
<td>28.7571</td>
</tr>
<tr>
<td>4500</td>
<td>15</td>
<td>450</td>
<td>375</td>
<td>33.7500</td>
</tr>
<tr>
<td>5120</td>
<td>16</td>
<td>512</td>
<td>416</td>
<td>36.7346</td>
</tr>
<tr>
<td>6780</td>
<td>17</td>
<td>678</td>
<td>539</td>
<td>40.7191</td>
</tr>
<tr>
<td>8480</td>
<td>18</td>
<td>848</td>
<td>643</td>
<td>44.6843</td>
</tr>
<tr>
<td>9220</td>
<td>19</td>
<td>922</td>
<td>726</td>
<td>48.6626</td>
</tr>
<tr>
<td>9690</td>
<td>20</td>
<td>969</td>
<td>792</td>
<td>50.9672</td>
</tr>
</tbody>
</table>

Possibly, with more extensive tables of logarithms than I possess, the value of A U might have proved even nearer than the true 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.

\[ \frac{b^3}{s^2} \times 3 = 8.48379 \]

From the preceding data we derive the following formulas for determining the value of A U.: —Put b = A B; \( \phi \) = the given cube, whose root is c; and \( \frac{1}{3} < A G \leq \frac{1}{3} \) A I.

The Table shows that, when the best divisor is taken, A B will be either less than \( \frac{1}{3} \) A C. Set off the lengths of these sides with a scale, and proceed to find the root by the method described.

**Example.**—Let 67178000 be the given cubic content. Divide this by any square number, say 422500, whose square root, 650, is one of the sides, A B; the quotient, 1303343, is the other side A C. When the process is complete, including the correction, A U will be found to be 820046, the true root being 820000.

To prove the numerical value of A U by calculation, proceed as follows:—Find the value of \( \frac{1}{3} \) A B, which is the versed sine of the angle A G; also, A E = A B is the versed sine of the angle A H. By the construction of the figure, when A I = 3 A H = \( \frac{1}{3} \) A G, from which A K, the versed sine of the angle A I, can be found.

Now the line A I = A R is \( = \sqrt{AC \times AK} \)

and, by proportion, A Q = \( \frac{AB \times AC}{AK} \)

Hence, A S = A T = \( \frac{AQ + 2 AR}{3} \)

And, finally, A U = \( \frac{AT}{AC} \)

From the preceding data we derive the following formulae to determine the value of A U.: —Put b = A B; \( \phi \) = the given cube, whose root is c; and \( \frac{1}{3} < A G \leq \frac{1}{3} \) A I.

(a) The sine of \( \frac{1}{3} < A G = \sqrt{\phi (c^2 + \frac{2}{3} \phi)} \); hence, \( \frac{1}{3} < A G \) may be found by a table of sines.

(b) The sine of \( \frac{1}{3} < A H = \sqrt{\phi^2} \); hence, \( \frac{1}{3} < A H \) may be found by a table of sines.

(c) \( \frac{1}{3} < A H = \frac{1}{3} < A G = \frac{1}{3} < A I \); hence, sine of \( \frac{1}{3} < A I \) may be found by a table of sines.

(d) Then, \( \frac{1}{3} < A I = \sqrt{\frac{2}{3}} \phi \)

The given example is worked out by logarithms as follows:

| (c) | \( \frac{1}{3} < A I = \frac{1}{3} < A H = \frac{1}{3} < A G = 30 34 257 \) | \( = 1877478 \) |

| (d) | \( b^3 \times 3 = 2.812913 \times 3 \times 3 = 8.48379 \) | \( = \frac{1574745}{3} \) |

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.
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, 1808, and was the son of William Robert and Phoebe 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 genuine love for his profession he steadily worked at it, 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 highest aspect, and it is perhaps to be regretted that he was on many occasions far too 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 considerable period of life had 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 eminent men 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 the Mechanics' Institutes of O. London, and the schools in which the curricula 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, and where the most intimate details of the methods 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 be young to be able to; but he nevertheless has a new proponent when new branches of study have 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 schoolroom 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, 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 leaders.

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, Graveshend and Brighton, Lyon, Wisbech, 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, but which, for reasons of health, he was compelled to abandon, and 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 undertook works 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.E., in the proposition of the Wensleydale 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 the profession, and paid the closest attention to 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 Mr. W. T. C. Durand, F.R.I.B.A. After Mr. Durand's death, the series 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, and where the most intimate details of the methods 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 be young to be able to; but he nevertheless has a new proponent when new branches of study have 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
were few men of whom he earned the ill-will, of many the respect.

At 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 organization of a professional constitution, there can be no doubt that this Journal has asserted itself and has obtained recognition by the government of the claims of professional men, partial though it be, in owing 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 secretary 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 organization 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 renewed, the policy of the course recommended with regard to the military engineers would be fully justified, and the services of those valuable officers be confided to that sphere of honour where they are so much required, and the Ordinance survey be committed to competent civilians of high professional eminence.

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 distinguishes our architects in the present day, and more particularly in raising the tone of architectural criticism. On the 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 realized, 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 of J.G. 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 continued 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.

Those 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 procurement of British and foreign patents and registration of designs.

Among other appointments, Mr. Laxton was entrusted with the surveyorship to the Baron de Goldsmith'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 effect. From the year 1806 to 1819, Mr. Laxton was also surveyor to the Farmer's Life 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, though he was no doubt a very able performer, was without doubt too great for his constitution. 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, Grey's-in-the-Street; the funeral being attended by the builders from Brighton, and by many who held him in high esteem, to whom his loss became known, and who were desirous of manifesting their respect for his life and labours.

The only son, Frederick William Laxton, F.R.A., was brought up by him, and was a matriculated student in the Department of Applied Sciences of King's College, but afterwards commenced a course of studies which earned him an eminent special peculier, 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 livemary of the Habershaders' Company, admitted in 1823.

REVIEWS.


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 it has exhausted every variety of geological formation, it is quite natural to have bethought oneself 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. In this work the author we found 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. He explains 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 places 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 half the interest of the other sciences, 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 obser-
vations carefully taken with approved instruments. Thus we shall
have the course of time and a more extensive collection made with
steam whereby we may more readily arrive at general laws. At pre-
sent, 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 whom unobtrusive labours the science is deriving
more 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 earth, and by this heat, which the denser portion of the
atmospheric gases absorb, heats the air resting on the earth; 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 lower column being thus
made lighter, and pressed with heavier ones on 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 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
the part of its heat, and converted into minute particles of water, which
float in the atmosphere as a soft cloud, and as such carrying 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.

The Practical Surveyor’s Guide, containing the necessary information

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 recknaff—a gath-
ering of old formulæ culled from the best and well-known authorities. We, however, leave Mr. Duncan to state his own merits at the same time as the books and if we are not
surprised 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 observation. A method of determining any part 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 become a surveyor of real estate. 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, plummet, &c. &c."
MILNER'S IMPROVEMENTS IN STEAM ENGINES.
was contained in one-half or thereabout of the first cylinder A, has not expanded so as to fill the half of the first cylinder A, and the whole of the second cylinder A′. The valve F′, 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 J′ ascends, shutting off the communication with the second cylinder, and the steam is then coming from 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 K′, at the top of the cylinders, are of 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 content 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 suit the conditions 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 E′, E′, are made loose upon the shaft, and are driven by stops fixed on the side of the socket of the reverse motion. The 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 courses 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 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 (indicated by dotted lines) to the top of the valve-box V, and the exterior of the valve T. Two passages or ports c, c′ 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. 8, 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 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 valve T, now bears the same relation as before described, and the pistons again descending, 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, and by the same process.

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 cylinders where the pistons are driven by 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 such 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 reservoirs at Highgate, from chalk springs upon the course of the New River between London and Hartford. 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 the raising of the reservoirs at 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 dispose of the period for construction with its use; but the whole will be finished before the Aries is passed for 31st August 1865.

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, 1865.

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 400,000l. provided for by the Act of 1863, will not be sufficient; but 300,000l. more will be necessary, making a total of 700,000l.

...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 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 38-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 of the execution of these contracts is satisfactory, to the amount of 5870 yards of the trunk main being 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 sub-merging 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 submerging 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 twelve months of the year, by the above statement is 5,531,419,989 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 privileges of 10 per cent. upon all water consumed, of increasing their supply in any degree required, as the engine power at Hampton and the trunk main are capable of delivering 30,000,000 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, and have constructed 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 38-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 Metropolitan 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 74,761l. has been already paid on the account of these works.

**East London Waterworks Company.**

This Company state that the whole of the works undertaken by them, in conformity with the provisions 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 Middleborough, Yorkshire, for the supply of 33,000 yards (about 11,000 tons) of iron pipes of 96 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 38-inch main, including the passing under the Thames at Richmond, and likewise for the erection of engine and boiler houses, and the formation of the new filter beds at Hampton.—With Messrs. Harvey and West, 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 works 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 suffering only with the bend of the stream to be quite safe from any 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 in 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, roads watering, and flushing sewers being deducted) is on the average 173 gallons, and the register's returns showing that about 63 souls may probably be the mean number of occupants of houses in the company's district, twenty-six 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 38-inch main, with the engine power provided at Hampton, will deliver at Battersea 30,000,000 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 862,000 superficial feet. The area of filtration, it may be remarked, is larger 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 distribution system of the company consists of upwards of 490 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 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-upon-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-upon-Thames, and have closed with the demolition 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 and premises 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 buildings upon which the court of directors have no doubt will be completed and in operation in the spring of 1855.

**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 Metropolitan 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 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.

**Hampton 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. Deguiseé and Laurent. The well varying from 9 to 8 feet in diameter, has been carried down 240 feet. From this point the boring was commenced, and has been continued by day and night, and it is expected that 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. Deguiseé and Laurent as to the thickness of the chalk stratum under which the well will be enabled to be carried will be 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 adoption of a compound of models from the hands of several 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 Rosebery, Marquis of Northampton, the Lord Lieutenant of Buckinghamshire, the Duke of Bedford, the Duke of Devonshire, Sir J. M. W. Turner, Esq., Sir J. M. W. Turner, Bart., the Rev. G. Poole, Dean of Ely, the Rev. R. Sheepehanks, Sir J. F. W. Horsel, Bart., and Professor Miller.

This committee presented their report in March 1844, 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 should be to act as a contact with the 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 described as not to become vested in the employment stated above, yet it is plain that the 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 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 the Imperial yard was, by Mr. H. Millington cousins, his task was entrusted to the Rev. R. Sheepehanks. 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 imperial yard standard, and at the Troy pound. They decided to confine 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 three Troy pound of the Exchequer Office; the bar of bronze found 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); Camden’s twenty-five feet bar, and Roy’s three Troy pounds (preserved at the Royal Astronomical Society, 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. Vaudone and Tifford). 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 yard, 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 this standard for the construction (or standard à traits), 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 from the point of support 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 more surely by supporting the bar at numerous points by dead weights or on frames which will insures 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 conception of secondary standards for commercial purposes, but it is doubtful whether it applies to secondary standards for scientific purposes, and it cannot apply to primary standards, in regard to which a constant value of length (in the law comparison of lengths which 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 metre 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 submitted to any scientific examination. 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 ingredients) perfect and elastic, 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, when cast or forged, is manageable, and prey to no invasions. 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 plan of experiment 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 $\frac{1}{3}$, zinc 1, appeared to possess every desirable property. It is hard; it is highly elastic, recovering its form (as
denoting the temperature which produces in the quicksilver an apparent expansion equal to \( \frac{1}{10} \) 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 standard of weight; 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 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 1.16 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 operated for some considerable time. This circumstance, among the rest, nearly took away all authority from other scales of a similar construction. From this and other causes, Mr. Sheepehanks determined, first, that no scales ought to be used for restoration of the value of the imperial standard, except those which had been compared with the imperial standard, or had been adjusted to correspond (in the proper proportion) with the value of the standard, in the possession of the Royal Society; among these the only admissible scales are, the Royal Society's brass scale No. 46, and the two 3-foot iron bars of the Ordnance Department.

The definition of a length, as represented by a standard bar, requires a standard of the temperature at which the standard bar is to be used. It appears, upon examining the amount of the expansion of a metallic bar for a given change of temperature, that the effect of a change of 0° or 0° 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. Sheepehanks commenced a series of comparisons of &quot;25 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 that two observations in particular, there were so great as to throw much of 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 would represent parts of the length of others. 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 20 or Nos. 2 at 61 94°.
- Bronze 10 or Nos. 5 at 62 15°.
- Bronze 2 or Nos. 3 at 62 10°.

The degrees of temperature for the use of these standards are defined as proportional to the corresponding apparent increase of weight, and would be represented in the following manner: representing the freezing-point of water; and the degree 218° 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 62° Fahr. 32° Fahr. 23 20 18, or 0 766 X 241 X 0 0000179 X height in feet above the sea; and the degree 86°.
of which one is numerical, and the other a multiple of that symbol; and the error of 4 x 1840 + 500 is also expressed by a numerical term and a different multiple of the same symbol. These weights being compared with the troy pound of 5760 grains, the value of the symbol was obtained, and therefore the error of any of the 1840 grain weights was known; and then a paper of about 7000 grains was formed by adding the troy pound and a weight of 1840 grains.

Five platinum pounds were thus prepared by Professor Miller, marked respectively, P 1844 1 lb, No. 1 P 1844 1 lb, No. 2 P 1844 1 lb, No. 3 P 1844 1 lb, No. 4 P 1844 1 lb, the specific gravities of which were found to be as follows:—

P 1844 1 lb
No. 1 P 1844 1 lb
No. 2 P 1844 1 lb
No. 3 P 1844 1 lb
No. 4 P 1844 1 lb

Comparing P 1844 1 lb with the representative of the troy pound in the manner just described, it was found that in air of the temperature 68-69 F. under the pressure of 30-750 inches of mercury (these being the means of the temperatures and pressures at which Von Neubus compared the ancient troy standard with the two platinum pounds),

P 8 = 0.0341 grain + 7000 x lost standard,

and this may be considered as the commercial weight of P 8.

Assuming the specific gravity of the lost standard to be the same as that of Vandersome, and that P 8 and the lost standard are composed—

No. 1 P = 7000 x 0.00082 gms.
No. 2 P = 0.00178 gms.
No. 3 P = 0.0014 gms.

The committee recommends that P 8 should be adopted as the Parliamentary Standard of One Pound, and that No. 1 P, No. 2 P, No. 3 P, No. 4 P, 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 immersed 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 performing which, while the quality standard pound weight, it appeared that the weight was by direct comparison, 15433.2482; 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 boute, 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 incorrodable 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 standard foot 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 facilities of using 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 the parliament. In the Custom House of London it has also been found necessary to adopt a series of weights in the millimscale 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 the required on the other side, and that thus an entire 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 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 desirable 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 the Exchequer, for public reference—

A muriel standard of 100 feet.
A muriel standard of 33 yards, or the land chain.
A muriel standard of 30 yards.
A muriel standard of 10 feet.

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 a similar apparatus.
A standard à boute of one yard, with a multiplying-lever apparatus for comparisons.
A standard à boute of five links or 1-1 yard.
Standard à boute of two feet, of one foot, or 0½ foot or six inches, and of 0½ foot or three inches, with a similar apparatus for comparisons.
A standard à boute of the French metre.
A standard à boute 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—

10 lb, 300 lb, (if judged necessary). 10, 20, 30, 40, 50 lb.
1, 2, 3, 4, 5 lb.
01, 02, 03, 04, 05 lb.
001, 002, 003, 004, 005 lb.
100, 200, 300, 400, 500, 1000 lb.
10, 20, 30, 40, 50 grains.
1, 2, 3, 4, 5, 6, 7 grains.
Small decimal subdivisions of the grain, for verification of crude 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 ounces.
01, 02, 03, 04, 05 ounces.
001, 002, 003, 004, 005 ounces.
1 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, quarter, gallon, pint, in a conical form; and bushel, peck, gallon, quarter, pint, gill, in a cylindrical form.
The new candle manufactory is situated on the left bank of 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 is 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 coal for the use of the works, and will also extend it to market, Hoggates 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, 30 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 bear 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 occupied by the 17th of April. The committee was disposed to give every possible encouragement to the media of instruction and amusement: 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, Belgium, Stockholm, Denmark, and various parts 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 Misses Fuchs and Siljestrom 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 Misses Cubitt and Company, for setting up at Mr. Cartwright'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 Science 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 conversation, 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, Conversations, Conference, &c., if it receive the full development which its great importance requires, will not be less than £8000.

IRON CHURCHES FOR AUSTRALIA.

Two iron churches in the building yard of Robert 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 46 feet in breadth. The interior is lighted on each side by a series of circular-headed windows, each 30 feet in length: and at the back by two large stained-glass windows. The vaul ted 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 of the machine.

British Association for the Advancement of Science.—The next meeting is fixed for Wednesday, September 20th, at Liverpool, under the presidency of Lord Harrowby.

Archaeological 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, 1864.

460. W. Melville, Locksway, Renfrew—Improvements in printing textile fabrics and other surfaces.

Dated February 24.

460. W. Macnab, Greenock, Renfrew—Improvements in steam-engines of the class usually termed trunk engines.

Dated March 1.


555. A. Barclay, Kilnamack, Ayr—Improvements in condensing steam-engines.

Dated March 12.

555. L. J. Barnache, Bordeaux, France—Improvements applicable to the prevention of accidents on railways.

Dated March 9.

592. J. Smith, Liverpool—Improvements in having axes.

Dated March 17.

638. T. J. Hearpach, Bristol—Improvements in the manufacture of mace from sewage, which are also applicable to other artificial manures.
THE NEW RECORD OFFICE.
NEW RECORD OFFICE, ROLLS BUILDINGS.

J. PENTNETHORNE, 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 hitherto scattered in a variety of places, exposed to destruction by fire or other causes, and almost always difficult of access. They are deposited, some in the White and Blue, and some in the Roxby at a distance, and others in the Room C, the Carlton, 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 120,000 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 halls 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 Lane, 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-aire. In 1838, Mr. Deering prepared plans for a fireproof building, such as the late Recorder's chambers, which were not acted upon, but other and more comprehensive plans devised by Mr. Pentthorne, 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 22 feet, and 15 feet in height; thirty-five 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 600,000 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 grilles, 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 faced with Portland stone, with a zinc panelled and embossed ceiling.

The sashes and doors-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 building is Messrs. Lee, and for the iron work Messrs. Grisell. The estimate for the portions already built amounts to 40,000l., 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 truthful 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 was:

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.

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.

5. Results: including specimens, from schools, of drawing painting, and needlework done by pupils in schools.
6. Projects for supplying desirable.

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 some 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 by 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 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 the career of the poor, unless the equal treatment of 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, 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 higher classes 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 9½l., by non-members for 11½l.; the specimens

No. 245.—Vol. XVII.—August, 1854.
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. Phrenological apparatus, the most recent and most elaborate models of steam-engines 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 instructive and amusing illustrations; while the ideas in all the drawings are so clearly given as to make the most crowded parts of the room comprehensible. Such a collection as this, 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 use the greatest care in selection, 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 Academies of Arts at Cadiz are especially deficient, while in some of those from France the distance is rendered to a few sketches from the Service de l'Arme, and the ruggedness of the faces of the Parthenes, 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.

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 Mr. 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 derived from them. Designs for school buildings, 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. These are the result of the insomnia of artists, 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 Jersey-street, which obtained a medal at the Exhibition 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 1s. 6d., 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 obstructs 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 public and of the school's work, which is of our best essay. The results of a year's study and work, and the accuracy with which the whole set of drawings are finished, is an example to be admired and imitated. The quality of the paper and size of the work are such as to give it the appearance of that which has been produced under improved hands. The prints are executed after the true art, and not by the assistant's hand, and the results are highly creditable to those who have collected and published the series. The students are instructed in anatomy, and are encouraged to copy from the best Greek and Roman statues, and to imitate the most beautiful productions of art. The exhibition is open to the public, and is well worth a visit.
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 it must be, with which we are indebted to our compatriots. In Sweden, the science of botany has, since the time of Linneus, been cultivated with assiduity. For a pupil to enter the University from the middle school of Stockholm, he must present a kersus sicus of the plants of the country, collected and arranged by his own hand; and he must 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 kersus sicus 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.

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 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 objects 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 course of its existence, the Smith's Art 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. Many have executed a desire in the minds of teachers to improve the style of instruction, and to aim at carrying out to the utmost the facilities heretofore 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 by Dr. Hooper, in his Lectures on the Art, "that which makes a man a participant in all that the human mind has attained to, of the rational, the true, the beautiful, and the good."
which had been 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. That the resolution of 1854 was not 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.

That the bridge was appointed by your lordships (20th May 1851) divided their inquiries into two points, 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 at Charing-cross, at the present site of Charing-cross-street, 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 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 1855, and Mr. Pakington, the Chancellor of the Exchequer in 1862, in both instances for a bridge to be erected on the present site.

Upon my being appointed First Commissioner of her Majesty's Works, a subject of a new bridge at Westminster was, at a very early period, brought under my consideration, and before the words, and in the intervals 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, in changing the proposed line of the bridge 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 offices of the India Board.

Although the adoption of this site had 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 my Report. In this instance, the failure of the Parliamentary purchase of property for the approaches, and in probable compensation consequent upon the diversion of the traffic from the present line, a large and unprecedented expenditure, such as, after duly considering the sanction of Parliament on the one hand, and the advantage 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 on this Board, to consult the opinions of the architect of the building on the subject; on the more important point 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 to 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 90 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 the bridge on the Surrey side, was seconded 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 attached by the adoption of the proposed line of Bridge-street.

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 which, upon the removal of the bridge from the present to the proposed line, would be attached by the adoption of the present proposal 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, and learned that that 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 Committee Bill came before them, would not assent to it.

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 that the number of carriages of all descriptions which had passed over the bridge within twelve consecutive hours of each day was 9200, while only 20 sailing barges had passed under it, and these had, for the most part, used the bridge on the Old Chelsea Bridge, which had only 30 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 equalising the gradients and reducing the headway as a necessary consequence of that step, were urged 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 20 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 Seymour, to adopt this site, and the consequent reduction of the bridge from 90 feet to 20 feet, 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 given charge of the preparation of the plans, met with the advantage of being authorised to submit 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 Commissioners of 1851; but considering that arches of a larger span, with corresponding piers and spandrels, 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 of seven arches; which, in addition to its other advantages, afforded better means of reducing the time necessary for the building of the bridge, 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 consideration which governed my conclusions, and which is it right that I should mention to your Lordships; I mean the embankment of the Thames. I am indebted to the labour of her Majesty's Commissioners for Metropolitan Improvements for much information in respect of this subject; and, in addition to the interest which I feel in the success of this work, I have a particular interest in connection with that of the bridge, inasmuch as the source of which to the welfare of the port of London cannot be over-estimated.

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 the Thames in regular navigable capacity (in breadth and depth), which constitutes the commercial value of a river, and a pre-eminent one at that. The embankment included the river, generally, within the limits which it now possesses, and brought into use culture millions of acres of rich land.
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 by the fact that the level of some of these marshes is as low as from 5 feet to 12 feet below the level of the highest tides.

In a letter from Mr. Newbold, one of the contractors for the immediate employment of the 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 constructed, in some instances, without the consent of, or by others in licence from, the Corporation of London, and in others by the authority of Parliament; which last class of cases, however, is not comprised in the forty-foot way constructed between the Tower and Allhallows, for the purpose of widening the work, as it was then constructed, viz., with cast-iron piles and plates in the foundations, and with Cheesewright granite, as the material to be used in portions of the piers, were as follows, viz.: Messrs. Myers, 286,701l.; Mr. Lawton, 286,414l.; Messrs. Mare and Co., 297,481l.

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:

<table>
<thead>
<tr>
<th>Material and Rem.</th>
<th>Charge for Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>£</strong></td>
<td><strong>£</strong></td>
</tr>
<tr>
<td>3400</td>
<td>Nothing</td>
</tr>
<tr>
<td>15,729</td>
<td>Nothing</td>
</tr>
<tr>
<td>6000</td>
<td>Nothing</td>
</tr>
<tr>
<td>286,701</td>
<td>286,414</td>
</tr>
<tr>
<td>303,830</td>
<td>279,855</td>
</tr>
<tr>
<td>206,438</td>
<td>206,438</td>
</tr>
</tbody>
</table>

The tender of Messrs. Marce and Co., was, therefore, 95,104l. below that of Messrs. Myers, and 43,189l. 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 to have convinced 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 be followed by the immediate resumption of the work at lower rates.

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 defective in certain particulars; that the deviations were such as to make 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 was 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 of 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 same, 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 tender, and 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 206,488l. This offer I have, therefore, accepted, subject to the approval of your lordship.

I would hereby draw your lordship's attention to the estimates which have been laid before Parliamentary Committees at various times, by eminent engineers, for a bridge at Westminster on a site now to be purchased, and a width varying from 44 to 60 feet. These estimates have been stated at from 90,000l. to 240,000l. for a bridge with iron arches and stone piers; and from 300,000l. to 350,000l. for a stone bridge. In referring to the lowest of these estimates, I am aware that a lattice bridge, a girder bridge, and even an iron bridge of the same structure, would be deemed more in keeping with the general design of the bridge, and that the structure would be much improved by the introduction of more wrought-iron trusses. However, I am aware that there is a universal sense that the design of a bridge in stone is itself such a beautiful design as to 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 203,586l., exclusive of allowance for contingencies and professional charges; for these, a sum of 10 per cent. is added, making the whole estimated cost of the structure 224,205l.

An expense will then have to be incurred (in accordance with the stipulations of the Corporation of London) for dredging the river to the desired level of 10 feet, and taking it 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 10,792l. will have to be incurred, making the sum for which it will be necessary to provide for services of every kind 285,000l.

Taking the total estimated cost of the bridge therefore, including the various contingencies to which I have above adverted, at 285,000l. The funds applicable to this service may be stated as follows:

I. Value of the Bridge Estate, according to a valuation prepared in the year 1844 by Mr. Hardwick, the Surveyor of the Bridge Commissioners 173,671
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 38,142
Total .................................................. 219,310
Leaving an apparent deficiency of 6,690l.

Your lordships will observe, that the amounts 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, if possible, in the lifetime of the present owner; and that, for a time, as 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 pecuniary advantages 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 800,000l. 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 25,000l. 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, dec, April 19th, 1854.

P.S. — In a report to your lordships on a subject of much importance as the building of great metropolitan bridges, it may not be amiss 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 Bridges, the erection of which has been traced to the year 1176, consisted of twenty arches, with a linear waterway of 450 feet above the old bed. Subsequently to the introduction of the great central arch in 1759, the waterway above the old bed was increased to 545 feet, and below them 258 feet. The bridge had a row of houses on each side of its carriageway, 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 1724, the total width of the bridge between the pavements 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 830 feet at high-water mark. The height or headway at the centre arch was 26 feet above the Trinitydatum. The width of the carriageway 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 expense on the bridge and approaches amounted, as before stated, to 389,500l.

The third metropolitan bridge was Blackfriars Bridge, begun in 1760, and completed and opened in 1790. It was constructed of Portland stone, at a cost of 180,000l., 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 Trinitydatum; a width of carriageway of 274 feet, with two footpaths of 71 feet each. Its steepest approach was 1 in 16, but that has been reduced to 1 in 22.

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 297,000l. It has nine arches of iron on stone piers, a waterway of 900 feet, with a headway of 27 feet above Trinitydatum. The cost of the bridge was 672,414l., and of the approaches 337,872l., making a total of 1,010,877l. Its roadway is 72 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 28.

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 Trinitydatum. The width of its roadway is 25 feet, and of each of the two footpaths 7 feet. The cost of the bridge itself was 836,000l., that of the approaches and river-side property and miscellaneous expenses, 313,000l., making a total of 949,000l. 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 on it a steepness of gradient 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 on a scale which rivals the ancient waterways of which amount to 919 ft. 9 in. The width of the new bridge is 151 ft. 8 in., and the headway above Trinity-high-water is 29 ft. 7 in. The width of the carriageway is 35 ft. 6 in., and that of each footpath is 9 ft. 6 in.; making a total width of 53 ft. 6 in. The cost of the structure itself is stated at £42,850l., 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 this time, added a sum of 859,084l. 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 has a waterway of 90 ft. above Trinitydatum, the centre of which is 322 ft. 4 in., and the total waterway of the three is 1258 ft. 4 in. The height of the bridge in the centre is 27 feet above Trinitydatum. Its width between the chains is 12 feet, and the cost, including the approaches, was 112,650l.

Treasury Chambers, 27 April 1854.

Sir—I am directed by the Lords Commissioners of Her Majesty's Treasury to acquaint you, that they have persuaded 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 estimate tender of Messrs. Monck, Co., for the work. Your Lordships are further pleased to authorize you to take immediate steps to carry this work into effect. With regard to the deficiency estimated at 25,000l. at the outside, my Lords will cause provision to be made in the Estimates for next year, or as much thereof as may be actually required for expenditure, and when the amount shall have been more accurately ascertained.

The First Commissioner of Works.

C. E. TREVILIAN.

DRAINAGE OF THE METROPOLIS.

The following is a copy of a letter from the Chairman of the Metropolitan Sewers Commissioners, addressed to the officer 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 300,000l.:—

1. Creek-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 drainings which we were enabled 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 300,000l.; 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 present powers, they succeeded in raising a further loan of 300,000/. 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. No commences 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 fulfill 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 direction, 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.

| Length of Main Line | Miles   | 7 840 |
| Length of Branch    |         | 4 4910 |

Total: 12 470

The entire cost, including all contingencies, is estimated at 300,000/.

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 needed for the disposal of the waste of entire districts, which are at present for the most part destined for drainage only.

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 excessive 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 790,000/; 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.

Supporting such an assurance to be obtained, then 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/, including pumping station, engine power, and 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, relieve the several districts 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 enlargement of the loans. The Commissioners have met, 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/, 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.

In a letter to Lord Palmerston, subsequent to the above, Mr. Jebb states that the Commissioners propose to devote 110,000/ of the 300,000/ 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) as will extend from the present outlet of the open sewer to High-street, Stoke Newington; with the remaining 190,000/, 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, Battersea.

The sum of 300,000/, which the act of last year authorised the Commissioners to raise, and which brought their debt up to 300,000/ (now to be 600,000/), was borrowed of the Rock Life Assurance Company, at 4/ per cent. on the security of the rates, the money to be advanced by the company in ten monthly installments of 20,000/ each, beginning on the 1st of March last.

MACHINERY FOR PULVERISING AND WASHING QUARTZ OR ORE.

Augustus E. L Bellford, Patents, June 1853.

The first part of this invention consists in the employment, for the purpose of pulverising quartz or iron 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 circle of 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 ball of some time kept all the time working point of the ball, and keeps the 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, 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 t, 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 A, 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 aniferous 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 p, 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 A, 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.

BURSELM 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 Bernoulli, 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 principle 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 act, and, in proportion to 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 ascertained.

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 of length and diameter. 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.'
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 besides, it is nearer the floor, that it must warm the carpet better, and so lessen the evil of cold feet. But 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 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 know that their observation is in accordance with the circumstance that a surface of any substance, like firebrick, which strongly resist the passage of heat through it, is 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 the heat produced by combustion in a common fire, one part—being somewhat more than half—is diffused, like the light, in 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 heated 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, by radiation, escape, but warm the solid or liquid 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 subatomic, 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 high alpine lakes are therefore, in the summer, colder than the sun—the colder they are. Thus, also, all persons who have attended to the subject know that aeroplanes, 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 globes, 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, because, in the experiment, that 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, that 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 assuming that the heated 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 may be, 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 mound of raising or settling on the surface of a field, is to 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, $a$, represents the fire-place or centre of radiation, with rays diverging from it into all free space around; $a b$, the wall in which the grate is set, and which can receive none of the direct rays; $a c$, the ceiling; $a c d$, the wall opposite the fire; $a d$, the floor, with the fire on 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 $a d$, first intercepts all the inferior rays, and then radiates them upwards 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 rays 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, kept 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 a little, 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 doped out of their property by a swindler, and afterward respectfully 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 remains in the room, and increases the temperature 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 is so much smoke, the possible good is more than counterbalanced by the ventilation above being rendered in proportion more faulty. In the 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.
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 pictures which adorn our churches and experimental 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 introduced into them as essentially conventional ornamental, 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, and may be considered as a somewhat of divine and 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 Saracen, 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 distinctly local, as those which are borrowed from Scripture.

Raphael 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 equaled. 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 result; for amongst the various objects which compose this picture, the interrupted columns, which appear 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 Raphael 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 that was called “Beautiful,” he has introduced a number of spiral columns, richly and elaborately decorated, by means where he 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 monotonous and 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, seemed to have become so much attached to their architecture in 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 Paolo Veronese, and is enriched with 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 is to introduce the greatest 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 picturesque nature. These architectural arrangements afforded him the means of diversifying his landscapes and introducing 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 Pauwles himself, in his picture of the modern town of Antwerp, by architecture, introduced columns, apparently of the Corinthian or Ionic orders, in paintings of David and Goliathe, “The Murder of the Innocents.” By Le Brun, now in the gallery of 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 enables scenes which without such ornaments would appear tame or trivial.

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 could perhaps never be attained 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 more interest to the divisions of the pictures. 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 succeeded in giving more importance to local and architectural subject.

The Dutch landscape painters, as Poelenburgh, Berghem, and Loutherburgh, introduced buildings and monuments chiefly as ruins, in which, forlorn condition, those 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 spoil their compositions by great abuse of the resources which it affords. Amongst these may be mentioned, Marco Ricci, Lingella, and other followers of the same school; they made the parts of their pictures the most, instead of the most important objects in their compositions. They avoided themselves their sojourn in Rome to copy the numerous monuments of various periods which there abound. This they did, however, without taste and discrimination; and in their pictures they introduced promiscuously, and in the greatest confusion. In this well of different kinds 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 fanciful style of modern romanticism, also 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 no very complete record of the remains 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 "Baalbeck," it is the remains of Belialba, the palaces, and other edifices, which cause 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 older 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—those who painted the real remains of ancient architecture, 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 bustling of the figures. The Venetian School afforded good examples of the former class. But it was obvious that even in those cases beautiful though they were, it had been necessary to exercise great thought and discretion in such accessories, he had committed some incongruities, in as 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 peculiar taste, 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, Sannichelli, and Brunelleschi, on the contrary, were highly successful as architects, great play of contrasts was exhibited in their works. And the so-called "Old Masters," introduced 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 the public welfare 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 Works, are entirely different from those of persons 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 cause 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 assertion is true so far as it becomes undoubtedly in the circumstances under which this fell disease operates, and the means of arresting its course, as are 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, are to be found in the early history of the disease up 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 insists in calling all the blame within this domain of history; whilst the former insists that the present course, 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 there is a great propensity for 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 a great cost of life and loss and life, with some attempt to estimate 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 merited 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. 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, etc., have in their turn, 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 to consider the value of the report on Quarantine; and indeed, notwithstanding the translation of this document into foreign languages, and its liberal distribution, doubtless 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 have been so suspicious of the intention of the towns of that kingdom 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 on the results of the Metropolitan Interments Act, a more striking failure than which could not possibly be imagined. Many condescending 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 has its origin, the system by which this board of health has been conducted, its 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 the State should not systematically carry on all personal farming. 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 "Phalansterie." But if the abstract question be passed over, we will 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 Cemeteries to obtain possession of their grounds. The Board, after uselessly negotiating 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 White City), 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 for proceedings. This offer had been rejected by the Company, with a view to get the Metropolitan Act (1854), 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/. The price paid for the Westminster Cemetery was 74,921l., its annual maintenance is about 4000l., 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. The Bill made the Board liable for the expenses of 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 Purifying and Distributing it.” The specific object 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 would be so produced would be beyond the means 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 generally with great softness.” This purity is attributed to 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 recommendations of the General Board of Health in this case would have been to have involved the Metropolis in an inescapable 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 which its position might stand. Hence the “water of Thames water may be derived 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 favourable system of the Board of Health has entirely failed to give 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.

Regarding the loss of human life, 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 arise from a pre-conceived or from a mistaken view of the physical conditions of the metropolis. But when the Board of Health publishes in 1854, that the “water taken by the Lambeth Company from the Thames, oppo-
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 town houses, even as at the present time. That astounding document—the report of the Trial Works Committee, they positively stated as the ground for this rule “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 it barely;” and literalists and the so-called realists have clung to this belief, and desired it as evidenced in the astounding document—the report of the Trial Works Committee “an increase of inclination beyond 1 in 80 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 8000£, were utterly worthless, because made for men who had no sense, 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, and has been exposed to 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 a single scheme on 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 shapeless, distorted statements of the General Board of Health is, 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 14d. per week; and that of main or sewer drainage (which, as above observed, is rarely brought to the houses, although the contrary is asserted in the Report) has been about 1d. per week.

But it appears from Mr. Bazalgette's Report on the towns especially cited by the Board of Health, as having been supplied with sewerage depositers, that the cost of water for a house has been on the average rather more than 16d., whilst the private works have varied from 5d. to 50d. Assuming, however, that the whole cost is, in towns of magnitude, only 20d. per house, the average annual rate to pay the interest on the capital, and to form a sinking fund to the extent of £100, Bazalgette states that this rate, at an interest rate of 5 per cent. must be 130,102d. per annum, or 6d. 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 10d. in the pound for public works, and 4d. in the pound to consumers, the annual charge without any reference to the cost of the private works is upon a cottage rated at 10l. per annum, 11s. 8d. per cottage. If the interest for the private works were added, this would be 17s. 11d. per annum, or 4d. per week. At Sandgate, the water rate is 1s. in the pound, and the sewer rate 6d. in the pound, so that adding for the private works as before, the charge to a 10l. cottage would be at least 11s. 3d. per annum, or nearly 6d. per week. In each of these five cases 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 combined have been entirely paid for by the inhabitants of Rugby, is altogether false, and all the expenditures 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 incidentally correct.

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 inviting your Lordship to examine for yourself, with the aid of competent advice, both the doctrine and the practice of that unpopular authority.

Geo. R. Burnell, C.E.  
14, Lincoln's-inn-fields, July 1854, 1854.

BRADFORD DRAINAGE AND SEWAGE.

The Street and Drainage Committee of the town of Bradford having commissioned Mr. W. J. 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 so 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 determine 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 unperceived—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, 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 the carrying off of sewage by the stream, and consequently ensure the constant movement of the water; the sewer is full 3 inches in 100 feet; the lowest in 150 feet; the curves of the bends are, as a rule, 90°; the strictest economy respecting the setting 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 accelerated, and the obnoxious matter will always be in motion, and conveyed at once to the outfall.

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 radius 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 to which it is applied to any 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. Geo. J. Shaw's warehouse, in Regent-street, where it is proposed on 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 21 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 to be accounted for by the nature of the subsoil. 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, which is a very desirable requisite for this purpose; but it is necessary to obviate 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 the 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 2800 feet, draining an area of 2091 A. 2 R. 14 P.; 1 in 256 for 3300 feet, draining an area of 1897 A. 1 R. 8 P.; 1 in 60 for 2800 feet, draining an area of 382 A. 39 P.; 1 in 30 for 3000 feet, draining an area of 189 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. Bazajette's scheme, approved by Sir W. Cubitt and Mr. R. Stephenson, M.P.), which falls 1 in 2400.

It appears from experiments by Dr. Robinson, that a velocity of 180 feet per minute will remove angular stones the size of an

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 up to the second bend; the velocity in the main trunk sewer is, of course, well within the limits respecting the settling 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 accelerated, 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 8 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 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 2093 acres; this area provides for a large increase of population.

It is proposed to construct the sewer of vitrified hollow bricks, equal in quality to those now made at Low Moor, the invert to be laid in Portland cement. The advantages to be
of which we are to speak to-day will be regarded as things of high value.

The lecturer then observed that nature warms by the sun, and in order to ventilating, that is to remove from among 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-smelling air, removed by the power 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 before it 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 hearth 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 the arrangement of that chimney, and of the chimney—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 the advantages of the improvements, and of the adjustments 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 lower 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 above.
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.
4. 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 opening, and foul air does not pass, but by them.

3. *The Windseat 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

---

* From the *Journal of the Society of Arts.*
The Civil Engineer and Architect's Journal.

Metropolitan Gas-Works.

To the Right Hon. Viscount Palmerston, O.B.M., 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, was employed in 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 gas-holders of the existing companies, to be distributed from those.

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 gases, 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 of manufacture, bringing with it greater facilities, enabling the commodity to be produced at less cost and in greater perfection, advantages 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 imperity, 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.

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.

The works have been executed by Messrs. Hopkins and Roberts, builders, from the designs and under the superintendence of Mr. John Tarring, architect.

Samuel Cleghorn, Jun.,
M. Inst. C.E., F.G.S.

11, Buckingham-street, Strand, 17th 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.]

Worse the very imperfect state of that part of meteorology which treats of the constituent parts of the atmosphere is considered, it cannot be matter of surprise that it is known to reach no 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 in use are based entirely on 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 medical, under which term are included all the various modifications produced by moisture, heat, and electricity.

The terms, or, in other words, the decomposition determined by chemical action, 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 206 of the former and 78 of the latter, and the other day by day present, such as the carbonic acid, ammoniacal, hydrochloric, nitrous, and sulphuric with sulphured hydrogen; the proportions of all of 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 has 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 M. Lasne, Dumas and Bousingsaulk 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. M. Bousingsaulk and Levy ascertained that the quantity of carbonic acid gas varied from 3.256 to 2.985 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 most frequently found in the open country. Carbureted hydrogen is found most abundantly in the neighborhood of marshy, nitrous acid gas in districts which are subject to violent storms, as it is supposed to be generated by the decomposition of azote by electrical action. M. Fresenius (Ann. de Chir. 1849, p. 506) states that he found the proportion of ammonia in the air to be in 100,000 parts in volume, 0.153 ammonia, 0.026 oxide of ammonium, and 0.379 carbonate of ammonia. But M. Bousingsaulk's observations upon the quantities of ammonia in rain-water show that it varies notably, according to the position, from 1 to 0.48. Under all circumstances, the air of the night is richer in azote 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 dew.

M. Chevallier (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 hydro-sulphate 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 Black Sea, and of having demonstrated the action of the sun's rays 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 infer with greater or less certainty that suspended in the atmosphere, though their existence cannot 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 density, 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 hygroscopic state frequently modifies the irregularity according to the seasons of the year. The occurrence of its action, 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 drier 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 winter morning, when the barometer generally rises; it falls about mid-day, rises again about 9 o'clock at night, and falls again to its lowest point about 12 o'clock at night. 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. The temperatures.

The mean temperature of London throughout the year is 50° 80', while that of the surrounding country is 48° 50'. The thermometer very rarely rises above 98°, and the greatest cold hitherto recorded in our metropolis is 0° below zero. The mean barometric range amounts on the 27th of July to 3 inches, and 15 inches on the 27th of 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 appears that the greatest part of moisture 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 dissolution 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 earth, it is not to 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 treatise on the branch of chemistry. The importance, however, of these compounds cannot be too strongly insisted upon, nor can the atten-
tion of scientific men be too decidedly called to them. Sometimes they act to destroy, at others to consolidate; but in all their influences serve 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 specification 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 schoorl, 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 schoorl occurs in smaller proportions. The granites of Aberdeenshire are more decidedly micaceous, and schoorl 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 of chlorite, 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 Chaussey, which are occasionally brought into the London market, resemble those of Cornwall, but are of a more delicate structure, MC. In their composition, they contain an amount of the same elements as the Irish; they 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 rock one, as in that of the Jersey granite.

The effect of the atmosphere on the granite is a point in 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 silicas, aluminas, and oxide of iron. In the felspar there is usually lime and potasses; 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 potasses 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 the state of oxide, tends to oxidation. The consequence is, that the felspar decomposes, and likewise the mica, but the first 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; while others, which have different rates of expansion of the constituent elements, may 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 rather to result from the composition 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 fine-grained layer rocks, as well as the hot springs, are covered by 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 retard it, in fact, under the upper shale, the expansion during frost will almost inevitably destroy their efficacy. If the source be caused by the action of the water and by the 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 modern application of the term "porphyry" is in some cases inconsistent with its derivation; the grey granites of Devonshire, Cornwall, and those sometimes called Spanish porphyry, commonly employed in the most ornamental purposes of the designer, 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 large proportions of iron pyrites, or black porphyry (green and white 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 hornblende and amphibole; the glassy surface of the sphere 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 basalt alter inseparably 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 aluminas, lime, and magnesia, which, in connection with silica, constitute their base. If any porous be present in combination with the silica in the shape of felspar, the action is more rapid, or, to express it in other words, of the hydroxylic acid 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 Chaussey, which are occasionally brought into the London market, resemble those of Cornwall, but are of a more delicate structure, and contain an amount of the same elements as the Irish; they 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 rock one, as in that of the Jersey granite.

The effect of the atmosphere on the granite is a point in 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 silicas, aluminas, and oxide of iron. In the felspar there is usually lime and potasses; 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 potasses 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 the state of oxide, tends to oxidation. The consequence is, that the felspar decomposes, and likewise the mica, but the first 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; while others, which have different rates of expansion of the constituent elements, may 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 rather to result from the composition 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 fine-grained layer rocks, as well as the hot springs, are covered by 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 retard it, in fact, under the upper shale, the expansion during frost will almost inevitably destroy their efficacy. If the source be caused by the action of the water and by the 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 apparent rock is composed of silicate of lime and silica, 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 formation of the calcareous cement the molecules of lime and silica are held together in such close contact 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 olitic, 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 quaries, and the exposure of the surface. The same is true generally of the use of the Anston magnesian limestone, and the marked differences to be observed in the Bath, Caen, and Portland oolithes, 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, under the influence of the interposition 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. There is no respect 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 base, tends to disturb the magnesian silicates and siliceous rocks, 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 the bases, tends to disturb the magnesian silicates and magnesian limestones. Attempts have been made to substitute the carbonates of lime, even if they do not offer extraordinary facilities for its action. But the generally received opinion is, that the azote, furnished by the decomposition of the animal matters which the rain-water, passing through the atmosphere, has caused to rain, leaves 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 the azote is a very easily desiccated gas, and 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 be inferred that 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 sapstressing 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 inconveniences. Limestones should be avoided in all 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 should be protected from the air 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 all the stones would be affected by frost. In the first volume of Rondellet's Art de bâtir, p. 307 (ed. 1849, Paris), M. Brard's process is described in detail; but some very curious experiments recorded in vol. 7, 1ère série des Annales des Ponts et Chausées by M. Minard, together with an article by M. Vici, inserted in the same volume, throw very considerable doubt upon the almost unanimous opinion of the author of the new church of Vincennes 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 cost much of labour, and at the same time of water very little, the action 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. Of the last objection 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 silice in solution, might furnish the element of the salture.

Of extreme importance have been the causes 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 Carboniferous limestones of the environs of Lyons, where 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 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 indistinguishable strata—First, because the joints 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 therefore 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 the heat, especially in a very porous stone like the Breton. 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 effluences 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 Rondellet's Art de bâtir, p. 307 (ed. 1849, Paris), M. Brard's process is described in detail; but some very curious experiments recorded in vol. 7, 1ère série des Annales des Ponts et Chausées by M. Minard, together with an article by M. Vici, inserted in the same volume, throw very considerable doubt upon the almost unanimous opinion of the author of the new church of Vincennes 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.

In many varieties of the dolomites, 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 nature of the materials in which they are embedded. When subjected to the action of the air, or any other fatty pigment which prevents moisture from coming through or absorbed into the stone. Which board 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 dolomites, 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 nature of the materials in which they are embedded. When subjected to the action of the air, or any other fatty pigment which prevents moisture from coming through or absorbed into the stone. Which board 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 dolomites, 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 nature of the materials in which they are embedded. When subjected to the action of the air, or any other fatty pigment which prevents moisture from coming through or absorbed into the stone. Which board 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.
THE CIVIL ENGINEER AND ARCHITECT’S JOURNAL.

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. In substance, the 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. But it is also to be observed that a good deal of the lime obtained from 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 minute salts to such an extent, that the salt, perhaps 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 in which they are exposed to the action of the air. Iron ores, for instance, which are 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 brick is likely to soften, and upon exposure to the weather their constituent parts will percolate. 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 furnishished 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, when exposed in store or in the open air, become, as the plasterers so properly 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 crystallization, 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 from the actual state of affairs, that the moisture 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, posolano, or other ingredient mixed with the slacke lime. When the setting has been once effected, the absorption of moisture by the atmosphere is the only cause by which the tendency of 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, which may be prepared, and which are used in the various operations of resisting the action of the atmosphere. The purer carbonates of lime when used for the preservation 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, which consist of the elements of the argillaceous marl, are not attacked by the salt of lime with the silicas and aluminas; 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 the materials 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 of the Parisian type and that of the Parisian which exhibited 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 crystallization be entirely taken from, they will remain in a powdery mass with 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 be observed that the air has marked influence upon the durability of some limes, and since the minute particles of sea-water it contains hold in solution many salts with which free lime has more affinity than with silicea. The decay of wood superinduced by atmospheric action, is caused 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 killed 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 exposed to them in store or in the open air.

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 it can lodge in 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 from the actual state of affairs, that the moisture 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, posolano, or other ingredient mixed with the slack lime. When the setting has been once effected, the absorption of moisture by the atmosphere is the only cause by which the tendency of 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, which may be prepared, and which are used in the various operations of resisting the action of the atmosphere. The purer carbonates of lime when used for the preparation of mortar, are excessively
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; many woods disappear through 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 intercepting an extraneous substance between the wood and the earth, in the opinion of those who, by covering the lower ends in sand, stove 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 to the coating, and if the weather be such as to prevent the direct 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 planned before being painted, in order that the paint may be applied in an equal manner over the surface. It is important also to test the moisture of the atmosphere, as too much affects the volume of the wood, but frequently alters the position of the fibres by producing a torsion analogous to that which may be observed in hygroscopic cords.

Of late years the processes of Kyanizing, creosoting, and immersing the wood in salt solutions 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 deuterohloride of mercury, appears to be most satisfactory; and among some striking illustrations of its results may be cited the cases 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 turpentine, until it has absorbed at least 7 or 8 inches. 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 manner in which the oil is introduced. Both corrosive sublimate, and oil of turpentine, 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 afford 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 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 cladding was incapable of yielding 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 beam. The failure of the bent timber ribs in such situations does not, therefore, in any manner detract from the action of one of the most successful measures that was tried for the purposes of preservation in the Theatre at Munich: a soluable glass was applied to the woodwork and scenery for the purpose of preserving, and, as far as possible, rendering them incinurable. 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 its action, either in the application, especially if it was injected under pressure. Professor Way's researches into the siliceous 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 to be 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; and on the other hand, the 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 hydrated 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 Malvot's papers in the Transactions of the Institution of Civil Engineers; and as we have no space to enter into the subject, we shall make some generalized remarks on the subject of iron, as far as they 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 in air and water 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 oxides, 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. Carboonic acid gas contributes much to this, for, under its influence, iron passes (to use a French word) into a state of Vichy. The moisture of Vichy is a hydrated carbonic oxide, 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 carboinic 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 carboonic 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 1836, respecting the fall of the bridge over the Maine, at Angers (recorded in the Annales des Ponts et Chaussees, vol. 28, 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 injure the one, and in course of time probably the iron. Vicas, in a note, in the Annales des Ponts et Chaussees for May and June, 1836, appears to doubt the correctness of this conclusion, but even he admits that the preservative action of the lime depends upon its absorption of carboinic acid gas, and that directly its hardening ceases, it loses its power of resisting the action of 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 in the contrary case, the addition of a very 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-line railway, the iron of the docks, and the iron of the railway, is 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 sulphuretted hydrochloric acid have almost the same effects, but the latter is more active on iron, 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 a condition more passive than when exposed to the air, and long as the latter is maintained, 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 1849 and 1851, (see note by M. Desargues, Annales des Ponts et Chausées, 1851) it appears that blank metal does not become passive in this protective condition, although 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 with 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 sulphuretted 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 composition 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 injury; and zinc, covered with a mixture of copper and brass, 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 analogous 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 decompose much more quickly than when they are independent of each other. Illustrations of this may be seen 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 brass, is in contact with iron in sea water, which is wrought iron. It appears, therefore, 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. 384. From this authority it appears that zinc, tin, and copper, protect copper from iron, whereas iron corrodes tin plate, but it is not so effectual 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 oxidising whilst the tin remains intact; and it appears that the degree of protection afforded by the tin to this iron 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 contains zinc, and deposits the carbonate of 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 calceous matter, which can thus be withdrawn from the main.

The class of atmospheric influences included under the term metaloxides of iron in the earlier part of this paper are not equally fully upon some of the metals than on other building materials. Thus the tendency 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 observers who have treated on this subject have been exclusively concerned 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 Mr. Wertheim to the Annales des Chémie et Physique (3rd series, vol. 13) 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 linear 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 1864,' and in the 'Annaire 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 hotter in the manufacture. Now the alkaline earths, and the nature 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 alkaline earth from which is gradually attracted (Knappe'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 analogous 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 o llegious iron 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 beyond the usual limits, I must refer the architect who would investigate them to the researches of M. Chevreul in the Memoires de l'Academie des Sciences, 1850 (vol. 22). I may, however, state that M. Chevreul attributes the solidification of paints to the oils that are found in an absorbing coating of the pigment, and 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 substances upon which the paints are applied have an influence independent of their mere capacity of taking up moisture. The various driers between the several woods and metals, experimented upon by M. Chevreul, indicate some peculiar differences in this respect, which have not hitherto been sufficiently examined.
APPLARATUS FOR MEASURING AND GOVERNING THE FLOW OF WATER AND OTHER LIQUIDS.

THOMAS TAYLOR, Patentee, November 15, 1832.

(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 a valve of metal coated 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 affect its revolution. It is evident that, however accurate the construction, a force of fluid, beyond a certain amount of 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 must be drawn off, without producing any effect; and although this quantity may be 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 referred to, the rotary 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 f; and to this centre is attached a drum 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 k,—its other extremity, after passing over a pulley j, being attached to an arm l, 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 i; which pipe extends outward so as to deliver a stream of fluid at a point almost in contact with the vanes of the drum a. Suppose the elastic force at the moment of action as shown in fig. 3, and 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 i,—the valve being kept to its seat by the elastic band k; 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 i, 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 a section of valve a, 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 joined a link j, connected to a shorter lever g, fixed to an axle a, one end of which is fixed to the valve e, and is turned with a handle f. 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 improved 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 latter, of a deferential conveyance of water, consisting of a hollow cylinder 4 inches diameter, 7 inches long, and 3-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, and the deposit of impurities left in the casing 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 scrubbling the surface with sandstone.

When the water to be filtered is very dirty, the stone cylinder is enclosed 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.

This filter also from experience that in the cases where the water is soft, and has been impregnated with carbonate of lead, from contact with leaden pipes or cisterns, this is entirely separated by the stone filter—an important sanitary advantage.
APPARATUS FOR MEASURING GAS, WATER, AND OTHER FLUIDS.

GEORGE HANSON & DAVID CHADWICK, Patents, March 31, 1863.

(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 upon the tube or bag, causes the said roller or rollers to revolve and discharge the fluid 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 a cock or faucet or other instrument 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 not introduced, the orifice A will remain open, and 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 will be charged with fluid; but, that press continued, the roller will be forced through 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 circumference 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 form of these ends being directed 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 situated 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 through the under part of the tube, then the orifice g, through which the 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 4. The tube or bag is kept in its central position by a ring of metal 4, 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 vertical expansion of which is driven upon the shaft 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 p, passes into the chamber q, the casing t, and thence through a wire-gauze r, into the tube or bag through the orifice 4, 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 ported through the bag by any ordinary outlet. 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 in the meter for water, construction being the same, being 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 PHENIX 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. F. Gilsey. Upon it formerly stood small frame buildings, used as sea row 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 dollars per annum, for which he has refused 100,000 dollars. 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 wherein stood the late store of W. T. Jones. It was 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 65 feet, and the new structure is to have a beautiful front of ornamental marble, and will cost not less than 100,000 dollars. 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.

The Canal-street building, proceeding as high as a moderate man can rise on a shrewd spade, is again taxed on behalf of the Brantreth building, standing on this corner, but not quite completed. The dimensions of these premises are 37 feet on Broadway, 128 feet on Canal, 128 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. Brantreth, and will not cost short of 180,000 dollars. 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 hairdressing business. Liberty in expenditure is to make this another attraction.

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 Service 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 main 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 of which are now occupied as residences. The others are now entirely occupied by tailor shops and retail fancy stores. They are all now nearly leveled 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 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 nearly 50,000 dollars. This is of white marble, and five stories high. Adjoining this edifice, three lots are cleared away, the substructure of the buildings being only the dirt. 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 the great improvements when finished, will make this spot the great point of Broadway.

We are nextintercepted 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 block, where the 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 building a highly-ornamental 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 a building that will together with the other things 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, Lander, 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 store that should defy competition. This work was energetically pursued, who was energetically driving it on. The plan is, to build a store on the Broadway side, and 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 policemen and rush and fire engines, and every tier to be finished and furnished in the nearest, 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 parquet, and at each of the orchestral chairs 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 3000 people, and in case of any great attraction 4000 people can be accommodated. The height from parquet to dome in 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 80 feet—20 feet wider than that of the Broadway Theatre.

On the second 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, when completed, 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 Guidinci, 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. Guidinci 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 cost half a million dollars, and have already gone 100,000 dollars. 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 November. 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 the largeness of a Broadway side, will be entirely adapted as a home for the drama, operas, 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 will, through 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 combat the theatre remove. 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 supposition of intrusive graveyards may be expected after another visitation of cholera has revived the dying activity of corporations and parochial authorities. The squallid, ill-drained, ill-ventilated, and demoralizing
dwellings or styles of the labouring classes are fast disappearing in favour of well-built, salubrious lodging-houses and workingmen'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 endeavours to supply a liquid less impregnated with mineral and animal impurities, by improved filtering apparatus, and have already supplied water of a good quality to a large extent 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 light as possible, and providing means to retain the vitiated gases and pernicious exhalations from crowded rooms and over-flowing 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 known to Bardwell's householder), but because our wilful stupidity and inexusable 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 inhabitants will have no evil of malarial or other dangers, day shall be avoided, and the people 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 deserts of the crowded and short-sightlessness of his landlord condemns him to lead. As the sciences are as useful as it is essential that they be made to be the property of every owner 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 houses 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 labourers 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 communication 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."

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. Wherever, however, the use of 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 plate slates resting upon fillets between the timber flooring joists, laying them in the same manner as sheet copper, 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 fire-proof 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 plates to the quarters by screws, one screw taking one corner of four plates. They may then be covered with paper, spill-proof, or ornamental styles may be run in cement, or metal, or leather; and for splendid rooms the plates may be enamelled in the Japanese manner.

This work contains woodcuts, but no description, of a domestic fire-grate, invented by Mr. Quarre, clerk of the works to the House of Parliament, which Mr. Bardwell pronounces to be "all metal, scientific, and beautiful," and by which about 30 per cent. 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 predicts. The grate is formed of ten aprons 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 household in the metropolis to be fixed from whose chimney opaque smoke is seen to rise. If ever such a glass company could get possession of 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 entitled in the erection of a pair of "third-rate" dwellings in London, which, if generally followed, by Mr. Bardwell (for a reason we cannot discover) imagine 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.

**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 semaphore had long proved too slow for the wants of scientific and inventive generations. At an early period the more diffuse 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 electrometers, offered facilities for signalling 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 civilized globe.

By slow and methodical steps the present era has imparted to the discovery advanced; since the commencement of the 19th century philosophers have occupied themselves with the fascinating idea of rendering the electric current subservient as a means of intercommunication.

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 telegraphy, 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 an iron rod, as described in a paper in the Royal Society Journal, was reported as having been accomplished. Numerous experiments were made in Leipsic and Paris by Winckler and N. Lomonier, 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 river, or one mile and two miles of wire and 40 miles of earth at Shooter's Hill; and also in 1748, by Franklin, across the Schuykill, at Philadelphia; and in 1749, by De Luca, 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 1737, describes a similar contrivance, the invention of Lemond and Reussier, of Geneva, in a letter to 'Fogia Magazine' for 1734, described an electric telegraph, in which sparks, emanating from wires, gave the observer glass tubes were charged with electric sparks, and the spark formed as an electric telegraph as a table of letters, by which many important telegraphic communications were conducted, and the graphical representation of words and ideas was transmitted. In 1794, Prince de la Paix presented to the King and Court at Madrid an electric telegraph, the invention of M. D. F. Salva, and which he used for conveying telegraphic communications. In 1816, F. R. de Coudenhove 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 lithographic paper and producing a red mark, indicated different letters and signs. The current of electricity was returned through the ground.

The profound researches of Volta, of Parma, on the development of electricity on surfaces in contact, of different metals which, when subjected to the action of chemical 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 Summering, 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 being the water, and the gas the sign 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 effects are to become more important in a short time, as is proved in the gutta-percha manufactories of Fonport 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 potassa, to which had been added a mixture of saturated alum and of sodium bisulphate. The writing is performed by making 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 wheat flour, mixed together with water; when formed, the plates are placed in a frame, system, as in the following manner, consisting 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 treated by boiling them over saltpetre, 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 1560 letters, composing a page or entire strip, are neatly drawn on the chemical paper.

In Bain's telegraph is in operation on the North-Western from London to Manchester, and from thence to Liverpool, an extent of 184½ miles, and in America on a line of 1249½ miles.

The last electro-chemical telegraph we can notice is that of Messrs. West 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 these telegraphs are, in general, of the magnetic needle or impart temporary magnetism to iron, or to produce electric currents by magnetic induction.

Professor Greister, of Copenhagen, was the first to deduce any important results from experiments on the magnetising properties of electricity. He ascertained, in 1819, that when an electromagnet is placed parallel to the direction of an electric current that is passing through the 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 observer; 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; and, 4, if the needle is in the plane of the electric current to deviate a 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. Among the rest, one particularly important is the law, which governs 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.

Other laws of electro-dynamical attraction and repulsion, experimentally established by Ampère, 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 are near, and repel when they are distant; 3, Repel each other when they are not in the same plane, and repel each other when their current approaches and the other
The force varies 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 by a current passing through a torus is 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 because the existence and direction of an electric current can be determined as a galvanometer, and, from the moment 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 telegraphy.

Dr. Turnbull's work contains several interesting particulars of the experiments of Ampère, Babbage, Henry, Faraday, and others, in connection with the subject of electromagnetism, 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 Credieu'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-discovered electro-magnetic properties. Ampère, in 1820, was the first to develop the principle in which the deflection of the galvanometer 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 1826, Proust suggested an instrument for conveying the telegraph message, consisting of conducting wires and compasses. In 1828, St. Amand proposed to connect Paris and Brussels by a metallic wire coated with silk, and enclosed 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 electromagnet sensible to the slightest influence, the signals conveyed by the deflections of which were to be determined at pleasure. In 1829 and 1833, Baron Schilling, a Russian Councillor 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. Muncke in 1836, in which light discs of cardboard, attached to magnetic needles enclosed in galvanic coils, were moved by the magnetic electric current. A thin copper plate, 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 the case one side of the cardboard discs, thus indicating, according to an established code, different telegraphic signals.

Between the years 1833-35, Commander Gauss and Professor Weber, two of the most illustrious philosophers of Germany, established telegraphic communication between the Astronomical and Magnetic Observatories of Göttingen, 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 15,900 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 magnetoelectric 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 conductors) of the wire were in connection, and also the two conducting wires of the telegraph. When the conductors were suddenly drawn off the magnet-base on which they rested, and immediately replaced, two induction currents of short duration were produced, one directly to the other, in opposite directions, which were transmitted through copper 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 two electromagnets.

In the coils of the multiplicator, a magnetic bar of about four pounds weight was suspended by 200 parallel silk threads, easily movable 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 to and fro with the movement of the bar, and was so directed towards a cylinder-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 bar it was moved, and, from the moment of deflection, the scale was presented to view. In this manner the signs indicated upon the cylinder-scale were made to convey certain conventional letters and words.

In the year 1836, Messrs. Taquin and Ettykhanzian experimented with the use of magnetic wires strung 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 stripes, and the movement of the paper caused the pencil to touch and mark 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 suggested by telegraph 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 end a forked wire, which when the upper 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 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 inserted in the sides of the paper 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 pole 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 a series of alternate and of an arrangement of a lever to vibrate; this lever has a click at its end, which causes a ratchet-wheel to rotate 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 the spring is so adjusted as to prevent the further winding up of the spring when powerful enough to give motion to the register, the revolutions of
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 electromagnet to advance; at each interruption and return of the current through the Babbage electromagnet, the type-wheel corresponded to the 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 put into execution only when the wires caused its need 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 electric current, acting upon a series of keys, light of which were marked with three letters of the alphabet, caused slides or magnetic bars to be withdrawn from under any particular set of letters, which appeared illuminated to the spectator by a lamp properly arranged for that purpose. Three wheels, one to serve for the direction of the observer, and two 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 magnetic-electric telegraph for a distance of 1800 feet. He employed the machine of Pixii to develop the currents that deflected magnetic needles placed at the extremities of the circuits. In 1838, Masson, together with Bréquett, experimented with this instrument, but failed to produce any satisfactory results.

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 galvanic current, and by means of electro-magnets, 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-presses; when the closed 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, which could be connected with the north pole 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.
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 all, with the single exception of the Kentucky canal, were abandoned at the ultimate object; and as the United States advanced in commercial prosperity, more extensive plans were adopted. In 1807, the senate charged the Secretary of State, Mr. Gallatin, to prepare a project for a general system of intercommunication by canals, based upon the geographical character of the territory of the Union. At the conclusion of the war, a general water communication between the Atlantic Ocean and the Mississippi was an object that we acknowledged to be an ideal, 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 greater Hudson presented a formidable 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 four years this work was commenced, and the velocity of the current at the head of navigation is marked, the term of years 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 $600,000,000. sterling; but its magnitude and proportions were still less adequate 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 5,000,000,000. sterling. The total length of this canal is 263 miles, and its cost of construction per mile was therefore about $13,700.

Meanwhile, the other states of the Union did not remain inactive. Pennsylvania especially rivaled 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 in the United States, in the year 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, 27,579,964f., being at the average rate of 6432f. 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 6000 miles. The average cost of executing this prodigious system of water-roads was at the rate of 6432f. per mile, so that 5000 miles would have absorbed a capital of above 32,000,000f.

This extent of canal transport, compared with the population, exhibits in a striking point of view the activity and enterprise which has characterized the United States; and, 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 8000 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 course of the Alleghanies, 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 Kanawha, the Savannah, and, to the southward, the Atalanta, 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 United States. The navigation of the Hudson 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 carry portions of their cargoes suspended 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 favor of portions of an essentially 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, being apparently impeded by the numerous offices of the paddle-wheel, 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 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 sawdust, worked by an independent engine, by which the steam now 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 force of the moving power 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 an hour 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 expelling 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. In the United States, some engines have 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 generally provided for driving the breather and blow-down cylinders, in preference to the main. 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 to the amount 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. Lonsora. London: Walton and Maberly, 1844.
stroke. The wheels, which are 43 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 paddleboards 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-steamer 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 outwater 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 toing 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, 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 Poughkeepsie, 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. Brooks, where the correct explanation is also given, being exactly the same as my own, even to the form in which the trigonometrical expression is expressed, the same fraction, 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 present misunderstanding being of the utmost interest and
utility, 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 principles of plane geometry.
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, carried
out with no bias of a particular belief, and 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 immedi-
ate 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
formulation performs. But may we state the real value of the illustra-
tion thus: It is only within a comparatively recent period of the
world’s history that the apparent motion of the heavens has been
finally reckoned with the supposition of a motion in the spec-
tator on the earth’s surface, and not in them; and while no
objection can be raised against adequacy of this supposition
accompanied with a hundred years’ successful utilization, there is no
reason 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, in order that there may be
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 curiosity of arguments tends to render the
conception of the rotation of the earth quite certain; for 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 the sidereal heavens, and yet are wholly explicable on the hypothesis of the rotation of the earth, not in twenty-four hours, and on no other.
To a person who views
the pendulum experiment, the rotation of the plane of its vibra-
tion is readily and speedily manifest; and because this may be
shown to depend on the rotation of the earth, it is not unnaturally
designed 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 unaltered 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
heavenly bodies in the pendulum being carried at its point of sus-
pension with the earth, appears to be one with it. But though
the earth’s diurnal rotation is less directly provable 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 the universe, must have been constant for that whole
period, or 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 plane
of its surface, there, therefore, the earth that moves, not at the
rate of the pendulum, but at some direction, fixed or one direction
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
material proofs meaning that interest and curiosity, it is
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 the mean of these; and if one of these conditions be impossible, 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
a determinate direction is a fact of truism, you see, and as 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 design-
ated 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 pur-
poses real, and not merely apparent on the part of the vibrating
planes. I have elsewhere, in a published diagram, shown that
the pendulum’s actual rotation is the resultant of two sets of contin-
uously exerted forces, one tending to keep the pendulum moving
even 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 this, I can illustrate 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 round to the point of touching, and will be the
fixed one. If now we roll 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 confounding two things, a free and a con-
strained 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 sec-
tional 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 supposed to move round a point in the line
in the middle of the cone; but every point with a veloci-
dy different from that of its neighbour in a different circle.
This is totally different from the case of a line occupying at each
infinitesimally-continuous instant a position parallel to itself, and
thus having all its points uniformly impressed with motion, and
required 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 irrestruc-
tively demonstrated, that while the cone continues to rotate in
the same direction, the line on its circumference moves as much
faster than which it always crosses; and that though this result is obtained by the tendency of the
to keep parallel to itself, coupled with the constraint applied
to it, it will not, after a complete revolution of the cone on its

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 deodorizing and disinfecting properties of charcoal, and the applicability of these to the construction of a new and important kind of respirator, he has desired to publish an account of an instrument he has invented and constructed, in order 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 fusing-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 4 or 5 inches, 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 lined with velvet, so as to admit of their being made to fit the cheeks 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 was 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 secured by clasps in the ordinary way.

The important agent in this instrument is the charcoal, which has so remarkable a power of absorbing and destroying irritating and otherwise irrepressible and poisonous gases or vapours that, armed with the respirator, spirits of hartshorn, sulphured hydrogen, and chlorine, may be breathed through it with impunity, though by no means without 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 a number of such gases as sulphured 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 embalmed in a layer of charcoal a few inches deep, instead of being prevented from decaying, as it has 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 before been shown; but it is shown that the peculiarities of charcoal to sewage-refuse lessens its agricultural value, and

temporaneously with the lessening of odour. From these observations, which have been fully verified, it appears that by strewing charcoal carefully powdered, to the extent of a few inches, over churchyards, or placing it inside the coffins of the dead, no escape of noxious odours can be prevented, but on the contrary all the adverse effects are totally prevented. The charcoal respirator embodies this important discovery. It is certain that many of the mismannates, 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 mismannates 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 mismannates, as effectively as it does sulphured 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 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 sulphured 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 disease, the wearing of the respirator for even a few hours may be expected to render harmless the malarious poison. 4. Those who, as clergymen, physicians, 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 with the sick. 5. The long-ling 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 designed to patent them, and designed only to apply his remarkable discoveries to the benefit of the public. 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 supposed to be 26 feet in height, 16 feet in width, should be 36 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 girders or beams, 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, invented 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 girders; the roadway e, is suspended by rods d, d, or otherwise to the bows a, a, c, c, as shown.

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 inverted 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 inverted 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 sunk 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 string b, of the bows a, and inverted d, may then be removed so as to allow of the full dimensions of the arch formed by the bows a, and the inverted d, being clear for the passage of traffic.

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 patent), 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.

The 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 versa.

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 invention fix any particular size of steam-stocks for the same effect, 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 or to 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 ordinary supply cylinder of 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-crest 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-crest 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-crest or valve-box, and let out in a similar manner; and to which faces and seats also segmental slides as here described, can be fitted, 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 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 troopship which was destined for the Baltic. While his brother's vessel, the Lisard, 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 immediate death. He was a member of the firm of Codrington 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 turfy waste. The process consists in first thoroughly separating, by and washing, all the earthy from the fibrous building would be 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, though simple, we are afraid will not come into 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 coin, and which is set in the register of the coins. Beneath the 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 Birkenhead, Liverpool, but the whole of the machinery was shipped 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 railway, water has come to take shape. The Scottish Railway Gazette states 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 interference 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 for that effect, or that great extent, can be secured. 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 supplant 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 clean, to all appearance as if it had encountered only the rains of our last wet autumn. 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 swell or crack or crumble. So that as an article of building, 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.

be used as templates for accumulating and marking the positive positions for the rivets and bolt-holes required in the plates, frames, and other pieces or portions of the machinery in the construction of true ships or boats, barges, tugs, masts, masts, spars, and other similar articles.

5. The Boston, Port, and Providence Steamboat Company—Improvements in steamboats. (A communication)

6. D. R. B. Clark, New Bedford—Improvements in the construction of savin and reeling machines. (A communication)

7. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

8. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

9. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

10. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

11. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

12. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

13. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

14. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

15. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

16. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

17. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

18. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

19. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

20. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

21. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

22. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

23. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

24. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

25. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

26. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

27. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

28. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

29. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

30. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

31. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

32. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

33. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

34. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

35. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

36. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

37. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

38. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

39. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

40. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

41. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

42. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

43. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

44. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

45. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

46. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

47. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

48. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

49. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

50. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

51. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

52. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

53. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

54. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

55. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

56. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

57. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

58. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

59. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)

60. The Boston, Port, and Providence Steamboat Company—Improvements in the construction of a new class of steam vessels. (A communication)
The four bishops 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 than no parochial minsters, 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 "Monasterio" places of retirement wherein persons might be brought up in a moral education and learning, to fit them for the service of God. 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 dioeceses 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 appointment 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 1432, for a warden and eight fellows; and the royal chapel of Windsor, in 1463, 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 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 amends 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

**ADDITIONAL CATHEDRALS,**

*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 accomplished 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.

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.
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 situated gives a name by which it is known. 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 course of things originally intended to facilitate the Reformation, but which has been considerably 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:—


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 some instances, it is stated that the mortar 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 18,000l.

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. The amount expended, aggregated at nearly 100,000l; a gradual restoration of the whole fabric, outside and in, having been in progress from 1832 to the present time. The north-west or Lanfranc’s Tower was rebuilt at a cost of 25,000l. At York, the restorations consequent on the two calamitous fires of 1830 and 1840, have been effected as a cost of 108,500l; of which 71,500l. was derived from public subscription. An additional sum of 6000l. has been laid out on the chapter-houses and the peal of bells. Hereford has been in process of restoration since 1841, and is still far from complete, although nearly 30,000l. has been expended on it. At Ely, the beautiful south porch of Bishop Bede (Tosun) has been restored, 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 17,000l. and, with the receipts from a fund contributed to this purpose, the funds contributed swell to a total of about 30,000l., inclusive of the late Bishop Sparkes’s gift of 15,000l. for the east window of the choir. At Wells, also, the choir has been restored, and other works executed, at a cost of nearly 15,000l. The Cathedral at Llandaff, having suffered great injury in 1728, 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 8275l. of which about two-thirds was derived by public subscriptions.

In several other cases smaller restorations have been carried out, which partakes 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 those the fund is very small! Where there is no special fund the repairs are maintained by small contributions from the chapter, which has been a customary practice in many cases, and in the process destroyed numberless tombs, thus altering the whole internal plan; and then, by way of finish, he “whitewashed” the walls (as probably he did himself too, in true Pecksniffian style); and hastened to make himself equally famous by being the first to name and publish the enormity of blocking, or fairly building up the arches between the choir and the aisles, making a sort of channel 200 feet in length, without side openings to give it breadth or relief. Another scene of his exploits is Durham; and there, by parking...
and scraping alone, he is said have removed full 1100 tons weight of
stone. He took down the pyraria over the north porch, sub-
structure and underport to the west tower. He actually purposed clearing
away the noble galleys, because it stood in the way of a conve-
nient 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; he was in time to witness the
proceeding to be taken, to be 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-gratification that better
times may have since dawned. Ignorance and inattention are no
longer venial; deans and chapters are not quite such sturdy bodies
as they were, nor can architects let loose their vagaries with
impartiality. There is little now that escapes the Lords of public
administration, and this has a tendency to put or preserve things on
their rightful footing. Church disputes are of course subjects on
which we do not touch: but who, while he lament the ill-starred
truths which are too often brought to light, can doubt that in-
quiries such as have been instituted at Rochester, Guildford, St.
Cross, Dulwich, and Stoke Figgis, will tend in the issue greatly to
strengthen the efficacy and maintain the purity of the Establish-
ment? 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.
Appointments like the one by Royal authority in the Church of
England, substituting 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), "so 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 arrange-
ments 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 bishoprics, 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 Lich-
field that they should choose their bishops alternately, and make
one archbishop: Bishop Godwin 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,
sembled in convocation, observed in their address, that
"although the population of England and Wales has been
depleted 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
future arrangements. The result has been published in such a way 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
published for a short time since, it must be printed," and, though it is presented in the humble form of "A Leader," there is a mine of information comprised which cannot fail to be of deep historical and archaeological interest. Perhaps there is no person better acquainted with the architectural remains in our last, who has been more deeply interested in, and their history,
the subject in question, than the author of this pamphlet. He
discusses the facilities as well as requirements of each county,
ceremonies, 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 for beauty, 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 cases would
appear suited to become their episcopal seats:-

1. Northumberland .......... Hexham. A very noble church;
2. Westmorland and Furness .......... Kendal or Cartmel. Good churches;
3. Part of the North Riding of Yorkshire .......... York. Whitby; Ripon.
4. The East Riding of Yorkshire .......... Beverley with Hull. The minister
at Beverley perfect, and a noble church at Hull
5. Part of West Riding .......... Wakefield, Kirkstall Abbey ...
6. Western Lancashire .......... Liverpool. No cathedral
8. Derbyshire .......... Derby. No cathedral
10. Shropshire .......... Shrewsbury. Nave of abbey church
13. Essex .......... Colchester. (No cathedral)
15. Berkshire .......... Windsor. (No cathedral)
16. Cornwall .......... Bodmin or St. German's
17. Herefordshire .......... Hereford. The cathedral
18. Somersetshire .......... Bath. The cathedral
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
interestest sheet to be convinced of the imperfectness of the present
arrangements, and the consequent urgency of 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 improve-
ment, is a remark which is corroborated by the events of our
daily history. We continually hear of the edifices and institutions
of bygone 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 inaply 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, it is wished that the new building may be 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.**

In the basement there is to be a room for the warming appara-
tus, 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 to the north side. We now come to the ground floor, the figure of which, as we
stated, and as shown in the annexed plan, is a regular parallelo-
gram, 100 feet long, 68 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 and 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 O, containing an area of about
500 superficial feet; adjoining the news-room will be a board-
room P, of 400 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 12 feet.

The principal floor will be mainly occupied by the great hall,
which will contain a floor area of 3300 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 spacious and imposing flight of steps, leading at their
footpoint of junction to a large open portico O, from whose
popular assemblages in the open air may be addressed, and which will be
sufficiently spacious to accommodate 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
granted to, or screened 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 which the ladies will sit list to view the enter, and in the
basement, by which the fire, Electrical and public office's, and an a 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 stair-
case, 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 chambers, and
also to the valves for ventilation.

The architect has chosen the style usually called the Cinque-
cento Roman, or that adopted by Michael Angelo, Palladio,
Palladio, and others in Italy, in the 16th and 17th 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,
triunented, bettered basement, relieved by large windows, the
jams and arches of which are to be deeply coved. Surrounding
this will be a double-plastered façade of the Corinthian order.
In the intercolumniation will be wide, arched windows, with
moulded archivolt.

The roof will be covered with Italian tiles of the local manufac-
ture, producing a pleasing effect from an essentially structural
feature.

The west elevation will have for its principal feature the en-
trance 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 sur-
rounding neighbourhood.

The east elevation is the same as three bays of the south side,
having in the centre the door leading to the rooms on the
ground-floor, and decorated with a suitable portico.

The north elevation on the north side is a combination
of plain and colonnade.

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 pilastered wall, with a coved and
painted 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 pur-
posefully done to aid the effect of sound, both vocal and instrument-
al, and to prevent the great reverberation and echo invariably
inherent in lofty and apparently well-proportioned rooms.

The building is intended to be heated by a hot-water appara-
tus, 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 for-
merly of Wolverhampton; and the builder is Mr. Young, of
Burbery, Mr. B. 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 water-
works, 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 reciprocating engine, direct from the river
into the cisterns of the consumers, without filtration, and distri-
buting 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 insufficient 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 system of 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 £8,000.

The company, finding the Corporation 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 treated; that the scheme was designed to receive, and the 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 subseeding reservoir to hold 400,000 gallons, into which the water will be pumped from the river; from thence it will travel to one of the following dimensions: two 63 feet by 50 feet, 8 feet, and one 40 feet by 50 feet, 8 feet, area 8576 feet, which are stated to be capable of filtering and purifying 900,000 gallons daily.

From the filter it will flow into a pure-water tank of 400,000 gallons capacity, properly from thence the water is to be pumped up 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 from the centre of the tank; the engine-chimney will be carried 188 feet above the surface of the ground.

These several works are described 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 occupation of that term; and whether, from the very imperious 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 system of supply. The authorities assert fire-plugs, which are upon the old supply—of forty gallons each are fire-plugs, which are upon the old system—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 is less; the works are capable of supplying, and the reservoirs 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 gallons per day for 316,213 inhabitants, with reservoirs amounting to 3444,000, and of capability of holding 97,907,931 cubic feet), will not, in those 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 report as they have reached us, without further comment, and express a hope, which is generally entertained, that the committee, after receiving these communications on future water supply of towns, that such measures may be copious and cheap, so that the humblest cottager may realise the full benefit of an ample supply, at a low rate, of that necessary of life.

[Copy]

TO THE CHAIRMAN AND DIRECTORS OF THE CHESTER WATERWORKS.

I have the honour of commencing my instructions to take the water supply into connection with the system of perpetual water supply, to be conveyed to the town in the best available manner, and to be properly treated.

After examining various situations, it appears to me that the most feasible and convenient measure to be adopted is by agreement with the Corporation to ensure the perpetual water supply, and to make the necessary arrangements for the supply of water into the town at a proper pressure and perfect filtration.

In the spring of 1844 I had the honour of receiving your instructions to take the water supply into connection with the system of perpetual water supply, to be conveyed to the town in the best available manner, and to be properly treated.

I am, &c.

[Copy]

THE WATER SUPPLY COMMITTEE.

[Sealed]—The drawings which have been submitted to the committee do not

W. BATES, C.E., A.I.C.E.
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 17,537,595, and this quantity is capable of being increased to 22,000,000.
The houses, manufactories, and public establishments were as under:

<table>
<thead>
<tr>
<th>Description</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Houses, manufactories, and public establishments</td>
<td>Total 90,924</td>
</tr>
</tbody>
</table>

FREDERICK INGLIS,
Clerk.

June 16, 1854.

Best London Waterworks.
The average quantity of water supplied daily by the company, during twelve months ending 31st December 1853, was 11,990,969 gallons.
The number of dwelling-houses supplied by the company during 1853 was 68,149.
The number of manufactories and public establishments supplied by the company during 1853 was 468.

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,
Secretary.

June 16, 1854.

West Middlesex Waterworks.
The average quantity of water supplied daily by the West Middlesex Waterworks during the twelve months ending the 31st December 1853, was 3,000,000 gallons.

An additional main, 30 inches diameter, has recently been laid from the works at Hammersmith into London, which is enlarged to a 30-inch main on leaving the company's reservoir at Bury 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 24,276.

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, barns, botanic gardens, markets, &c., is 23.

The augmentation of manufactories and public establishments does not, however, include several other trade establishments, such as livery stables, omnibus establishments, cow-yards, nursery grounds, &c., or charity-schools, almshouses, dispensaries, &c.

W. H. WILDPIN,
Secretary.

June 20, 1854.

Grand Junction Waterworks.
The average quantity of water actually pumped daily for six days in each week, from the 1st of January to the 28th of December 1853, amounted to 9,208,588 imperial gallons, equivalent to a daily supply delivered for each of the 365 days during the year, of 5,116,675 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,
Assistant Secretary.

Southwark and Vauxhall Water Company.
Quantity of water supplied by the company, from the 1st January 1853 to the 31st December 1853.

<table>
<thead>
<tr>
<th>Description</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total quantity pumped in the year</td>
<td>2,852,578,377</td>
</tr>
<tr>
<td>Being an average per week of</td>
<td>33,011,936</td>
</tr>
<tr>
<td>Or an average per day (for six days in the week)</td>
<td>4,501,327</td>
</tr>
<tr>
<td>40,045 Houses supplied, averaging per day, 176 gals.</td>
<td>7,001,957 gallons</td>
</tr>
<tr>
<td>634 Consumers, namely, railways, distilleries, road-watering, fire, flushing sewers, and trades generally, averaging per day 2265 gallons</td>
<td>1,500,000 gallons</td>
</tr>
</tbody>
</table>

40,500 tenants, averaging per day 209 gals. 6,001,877 gallons.

This supply can be more than doubled if required; the 80-inch main, with the steam-power provided at Hampton, will deliver at Battersea 20,000,000 gallons in the twenty-four hours.

JAMES ROBERTS,
Secretary.

June 29, 1854.

Lambeth Waterworks.
The average quantity of water delivered daily by the Lambeth Waterworks Company, in the twelve months ending 31st December 1853, was 5,000,000 gallons per diem.
The supply can be increased from the existing works of this company at Seeding 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, 1846, the supply of water may be carried to an extent as great as may be required.

The number of houses and manufactories in the district is 26,083, and the number of public establishments 624 in number.

W. S. PRYCE,
Secretary.

July 20, 1854.

Chelsea Waterworks.
The average daily supply of water by the Chelsea Waterworks Company, during the twelve months ending 31st December 1853, was 5,000,000 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 Magdalen-House, 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 22,785, and the number of manufactories and public establishments 2004.

ALBERT GILL,
Secretary.

July 21, 1854.

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 2,146,750 gallons.
The average 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 to those 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, bleacheries, gasworks, railways, and steam-engines.
Water was also supplied for fishing purposes, and road and street watering.

W. R. MORRIS,
Engineer to the Company.

June 14, 1854.
FORMING SHEETS OR PLATES FROM SLAGS.

GEORGE ROBINSON, Patentee, August 27, 1855.

This invention consists in the conversion of the molten slag (formed in the daily process of manufacturing, puddling, and refining iron and other metals) into thin plates, by pouring it upon an iron or other table artificially heated, wherein 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; and after the sheet or plate is formed, by means of a suitable 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 ornamentations 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 manner 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 puddling; and secondly, the formation of a molten slag on tables artificially heated; and, thirdly, the application of the sheets, plates, or slabs thus formed to roofing and other useful purposes.

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 un instructed 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, will see two roads at right angles, direct north and south, 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 periphery. A third person would think of laying down a horizontal line, a perpendicular line, and the south and west drifts in their relative position to the north and east roads. The falsity of this figure must be apparent to every person. We perceive, then, that every diagram must be constructed either by the method of lines, or by the method of images, or by combination of both, or by both."-

The third proposition of the 16th Book—"How to inscribe an octahedron in a given cube." The cube of floor space 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 direction. Many other bodies in nature which a diamond was one, possessed the same properties in this respect as floor space.

The ready way in which some minerals cleave was illustrated by breaking some portions ofcalcaceous spar, the fragment was always cleaved parallelly to the face of the cube, a solid known by the name of the oblate rhombohed, the angles of which were always similar. White marble, reduced to the finest powder, presented under the microscope no rough fragments, but sharp and definite rhombohedrons. This 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 could despair because a subject had presented almost insuperable difficulties to the greatest minds. Linnaeus, 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 Hazy, the property of cleavage, had been carefully investigated by Newton. In the "Opus" 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.

In giving an idea of the nature of Hazy's labours, it was shown that the Comte de Bourvon, 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 different figures and combinaisons, and far surpassing the simplest geometrical relations to the rhombohed 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 geometrical relations, are 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 from 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 greates 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 writings on a plane of abstruse science.

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 the importance of the science of mathematics, which has been placed in vantage points in various countries for the sake of 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 sample form should be of the same colour throughout the representations of all the combinations.

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 the ancients had adopted the names 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, manitivated with a peculiar purpose in the design of the Creator of the natural world. After the investigation of the scientific value of these forms had slumbered for many ages, the genius of Hazy gave the first glimpses of their practical application to a revelation of some of the most recent advances of science. A number of bodies, the form of a perfect octahedron, one of the Platonic bodies, whose edges were about an inch in length, was exhibited. The fact that floor space occurred frequently in perfect cubed streets was shown. By possession of this property, floor space split 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 floor space afforded a demonstration of the last proposition but one of Euclid's Elements—the
THE GREAT GANGES CANAL

It is not long since, when, in the course of our comments on the canal 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 not strange. The three miles of canal now before us are the remnants of the great work to which we would now direct attention, which 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 before it would even be considered in a condition of any importance to the public. It is intended to be built. Advice from India, however, has 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 in 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. The brief and 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 Secostor, 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 famous canals of Egypt—built after the skill of Secostoris, exhausted the immense resources of Darius, the Persian, and finally required all the Greek talent and Egyptian ability at the command of Ptolemy Philadephos to complete,—the canal connecting the Nile with the Red Sea, was built 1000 stadia, or 135 English miles long; the length of this system is 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, are agreed 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 workshops of India and such assistance as could be found for the employment. With such means and such assistance, he has been able to build the Great Ganges Canal, which we shall now attempt to describe; to 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 Hardwar, and at that point breaks through the Sewalik Hills as a pure and plentiful stream, flowing over a bed of great stones, and separating into several branches, one of which passes under Pyre Ghat, the most sacred of the bathing places of Hindus. The Ganges then turns off a little to the eastward, and flowing past Khunkhel, 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 the main river and the branches 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 Pyre Ghat branch of the Ganges, and a regulating bridge of ten arches, each 20 feet wide, across the channel of the Pyree branch. For the latter purpose the admission of water into the branch, down which natives may come, which wish to bathe in the sacred water. Between the Mysoor 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 constructed, between Hardwar 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. It is over three miles long, paved with stones, and has 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 30 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 Sewalik Hills. On this aqueduct the Government have expended a sum of not less than thirty lacs of rupees (300,000 sterling). It is founded on elaborately series of blocks of masonry, sunk 30 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 workmen employed in the construction of the work—where a college for their education was some years since founded by the Government—the canal is 100 miles and has cost 700,000. It then proceeds southwards in a single line to Nanoo, 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, are built greater than three miles, and to each bridge there is attached a main irrigating canal, whereby the water is carried to the adjoining villages. The length in a straight line, as we said before, from the canal-head to Nanoo, is 180 miles; the breadth at bottom 140 feet, diminishing gradually as it reaches Nanoo to 80 feet. Between Roorkee and Nanoo, are three great branches, one leading to Futebhoo, leaving the main line at fifty miles from the head; the second to Bolundahak, leaving at the 110th mile; and the third to Kok, leaving at the 152nd mile. The two last ultimately unite, and form one branch, used for irrigating the great district of Hattras.

At Nanoo, the canal branches into two separate lines, directed respectively on the Ganges at Cawnpoor, and the Jamna below Etawah. The total length of channel navigable throughout, including the trunk and terminal lines, with the great branches, is 600 miles long; and besides the canal, which escapes, with waterways, varying from 800 feet to 18 feet; 902 bridges for the purposes of regulation and cross-communication, with waterways varying from 900 feet to 20 feet; 297 inlets for local or minor drainage; 18 falls for regulating the slopes; 318 inlets, 3500 drains, 208 large drains, and 1722 small drains, 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; which have cost about 700,000. 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 others is next, and which are distributed 17 cases of the office of the records must be examined; and there will be found the proof of the truth and care and immense toil with which every part of the grand design has been elaborated by those concerned in working it out. Nor should those whom execute works of this magnitude 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 man, the master workman, the fitter of machinery, burner; in fact, the man of all detail work or of 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 1,450,000. per annum. The water rent, from the most southern branch of the canal, is estimated to produce about 130,000. per annum, while the transit duties and
other items of revenue are reckoned at 18,000L. The annual charge for maintenance is estimated at 40,000L, 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 125,000L, 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 and at the same time most interesting facts that have taken place during the last generation. 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 the frequent 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 mill, the same land 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 speculation 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 speculative 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 gools and empty bottles. Now, however, the joke may pass harmless. The Ganges Canal is the standing answer to the sarcasm.

MATERIALS FOR PAPER MAKING PROCUABLE 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 various industrial paper is made from the leaves of many grasses, 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 the leaves, after the seeds and stalks have been separated, is boiled until thoroughly soft, and this flake or paper pulp is mixed with water and used for paper-making. 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.

One plant that has long been known to be valuable for the production of fibrous material is the Sisal, and 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 as much 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.
THE CIVIL ENGINEER'S AND ARCHITECT'S JOURNAL.

THE QUALITY OF FIBRE WHICH MANY OF THEM CONTAIN. This European produces the enormous quantities of meat exported from Russia. Corchorus olitorius and Corchorus Capitatus, the leaves of both of which are used as a vegetable, yield the large supply of jute impressively, as it is mainly cultivated and 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 gummy barks. Some of the Leguminosae also abound in valuable fibres. Crotalaria juncea yields the common sunn of India. Sesbania Campana yields the dhanchi of Bengal; while Bauhinia Rosea is used in making rope bridges in the Himalayas. The fibre of Parvinia amarae was sent to the Exhibition in 1861 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 mucler of India, and 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 broad-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 something similar to the American paper, which is described as being probably the best parish for its quality as a rag paper. I believe that the refuse cuttings of the bush cultivation of the mulberry in Bengal might be turned to profitable account. The banks of many stinging (Uvixia) and of stingless (Boehmeria) 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 aidia, of grewia, of corchorus, of tritomata, and of many other genera, might all yield an abundance of useful materials, 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 dung; 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 prices were taken by the consumers in Europe to encourage the planter or colonist of a distant region.

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 paper-making 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 the lock-pits of Wigan and Lyon, 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 Jess 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 American, who has purchased largely in cotton 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 the 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 line 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 $24 to $26 per lb. for a partially-prepared pulp is generally considered by most makers to be too high, and they think the material to be much more likely to be acceptable if it were perfectly prepared. 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 $24 to $26 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.

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, agricultural state of the Marshes on the Side 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 bank of the Thames below London Bridge, which it appears extends 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 malignant 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 places 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 believe to be 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, and it increases the quantity of disease and mortality, 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 main ditches; this seems to justify the Committee a new source of nuisance of dangerous character, and one by which any means be such as simply to recommend the proprietors for the necessary cost to attend 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 affect 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 installments, spread over a period of years.

In order to carry out the improvements which the Committee consider indispensable, it will necessarily 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 the value rate assessment offers, at the present time, the best criteria for ascertaining the relative 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, which would be advantageous made in the mode of their appointment by the introduction of the elective principle.

---

**Estimate of the Expense of Draining the Marshes or Low lands between Woolwich and Erith.**

**TO THE COMMISSIONERS OF SEWERS OF DARTFORD AND OTHER LONDON TOWNS.**

**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 plans to be taken, to ascertain the heights of the present situations above low water mark, and collected other information that will enable me to furnish the instructions that you have already requested.

I find that low-water mark on the 1st and 2nd instant, was about—

- 4 feet below the Green Level Sluice; 5 ft. 2 in. below the Great Breach Sluice; 3 ft. 8 in. below the Abbey Level; 8 ft. 8 in. below the Old Corn Marsh Sluice; 6 ft. below the Crab Tree Level.

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 wagon.

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 be through Abbey Level, as it now does.

The putting up 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 £1600.

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 £1600; and I am of opinion that it would be much to the interest of both land-owners and tenants if they were made, and these ditches taken into consideration, 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.

I should recommend that the water in the ditches be used, and supplies should be furnished to what I recommend in my report, dated December 1847, but at 12 feet lower level, and this alteration I estimate at £600.

The alteration made in the level of the fresh water in the ditches would involve the expense of raising drinking places for cattle, and £600 of opinion that this would make all that was done before useless, and the whole of these works to be carried out, the cost, per annum, for all the levels would be under £250, the total amount being £3000, and the number of rateable acres 2923.

I have measured the height of the ditches in the levels, as shown on the plans, and find them to amount to 141,900 cubic yards; and, taking them at an average width of seven feet, the area would be equal to 635 acres, and of this extent I find we could stop up 123 acres without any change in the proportions of the cost of the levels were the proprietors of one household, 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 the excavations have been diminished since I entered on this work.

I am of opinion that the plans here suggested would be carried out without any great expense.

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 object to which I must beg to draw your attention, viz., the sewage and drainage of the new town now growing up between Pimlico Common and the railway, which is now taken along the railway into the Crab Tree Level. This is but very little, if any, subsidence 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 1800 to 2000.

I think, however, that you ought not 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. Groves, Southwark, December 3, 1856.

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 held 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; then the matter was removed, and there have been no active steps taken since that meeting.

---

**OBTAINING LIQUID CEMENT, AND PIGMENTS OR PAINTS.**

**GEORGE BELL, Palentine, May 11, 1853.**

This invention relates to combinations of lime with certain other materials in the production of liquid cements, pigments, 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 materials are mixed in the proportions given: viz., six bushels of slaked 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 three bushels, of ochre, and six pounds, or three bushels, of umbre; when this mixture is boiled and reduced to the requisite 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 walls and other situations, six pounds weight of gum-arambic and one-pound weight of lamprey are added to and dissolved and mixed with the above.

To produce a black paint for common purposes, the following materials are combined in the proportions given: Two pounds of slaked lime in powder, two pounds of sulphate of iron and 2 gallons of water, and ten gallons of gips tax. These are mixed together in any suitable stirring apparatus, and are then fit for use.

An elastic paint, suitable especially for damp walls, but appli-
cables for other purposes, is produced by combining one hundred-weight of oxidized oil or oxide of zinc, twenty-eight pounds of refined lime, dry; and one gallon of a solution of indiarubber, diluted with one part of linseed-oil and two parts of spirit of turpentine. In obtaining this latter combination, the oxide of zinc or oxidizable of zinc 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 paints 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 HOMES, 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, where it is constantly a quiescent 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 retorts 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, 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 in all cases done by gas engineers. The gas passes off at the upper part of the conical chamber of the retort into the hydraulic main, shown, and it passes from the main by the outlet-pipe a. 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 matter that is adhering to the tube. The passage of the water in the hydraulic main is allowed to flow away, these being a small opening in the partition for that purpose just above the water. The flow is returned to the retort, in the tube c, which enters the vessel d, and covers the in the vessel under the inverted vessel. The retort may be used for distilling from coal or other materials, and when suits be used, such as coal or other oils, they are supplied to the retort by an apparatus such as is used for conveying waxes to the retort.

This invention does not confine; the description to the use of the precise form of retort shown, as it may be adapted to what varied, without departing from its essential 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 PAPER-MACHE.

CHARLES BAYER, Patentee, July 19, 1853.

This invention consists in first producing a pattern or design upon paper by pasting 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 transfer applied thereto, in such a state of powder or leaf, as to be in a finely-pulverized state, which will resist the action of acids or other agents employed to act upon that part of the surface not covered by the paper. 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 before being transferred, the paper removed, and the process proceeded with as above described. When required to ornament glass and metal surfaces with vitrifiable colours or 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 resinae 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 theretoe 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 thereto. The gold or silver leaf is removed from those parts which the pattern does not cover by biting with a tool 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 thence 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 (surprising the pattern to be produced on the 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 anharshnatic coal reduced to fine powder is then applied, or in some cases metallic or other leaf, which adheres to the paper only, and removes it impartibly 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 vapor of spirit or oil, to enable the resinae or other material or composition employed to incorporate itself with the impression; and then fusible acid (or other material having similar properties) is applied in the usual way on the face of the glass. 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 retorts 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, 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 in all cases done by gas engineers. The gas passes off at the upper part of the conical chamber of the retort into the hydraulic main, shown, and it passes from the main by the outlet-pipe a. 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 matter that is adhering to the tube. The passage of the water in the hydraulic main is allowed to flow away, these being a small opening in the partition for that purpose just above the water. The flow is returned to the retort, in the tube c, which enters the vessel d, and covers the in the vessel under the inverted vessel. The retort may be used for distilling from coal or other materials, and when suits be used, such as coal or other oils, they are supplied to the retort by an apparatus such as is used for conveying waxes to the retort.

This invention does not confine; the description to the use of the precise form of retort shown, as it may be adapted to what varied, without departing from its essential 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 PAPER-MACHE.

CHARLES BAYER, Patentee, July 19, 1853.

This invention consists in first producing a pattern or design upon paper by pasting 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 transfer applied thereto, in such a state of powder or leaf, as to be in a finely-pulverized state, which will resist the action of acids or other agents employed to act upon that part of the surface not covered by the paper. 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 before being transferred, the paper removed, and the process proceeded with as above described. When required to ornament glass and metal surfaces with vitrifiable colours or metals (in the state of powder or leaf) are rubbed into, mixed with, or applied on the pattern produced in the resinae 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 theretoe 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 thereto. The gold or silver leaf is removed from those parts which the pattern does not cover by biting with a tool 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 thence 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 (surprising the pattern to be produced on the 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 anharshnatic coal reduced to fine powder is then applied, or in some cases metallic or other leaf, which adheres to the paper only, and removes it impartibly 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 vapor of spirit or oil, to enable the resinae or other material or composition employed to incorporate itself with the impression; and then fusible acid (or other material having similar properties) is applied in the usual way on the face of the glass.
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 lithographie printing, while the ink is still wet or damp a resinous or resinous composition reduced to powder is applied thereon. The paper is then exposed to the vapour of turpentine, in which the resinous particles are preserved; and air is passed over the surface so as to dry the paper and oil in the lithographie ink to combine and form a varnish. Or, instead of exposeing it to the vapour of turpentine, it may be exposed to heat or even allowed to remain a certain time, when the matter will of themselves combine and form a varnish. The paper is then transferred to the article to be ornamented, and the process which has been described is repeated, and, if necessary, until the article is covered with the design proposed, according to the size and number of objects to be ornamented, and the thickness of the varnish required; and the varnish or varnish and enamel, as required, are then applied in the manner described.

Assuming all as described above, the passage is continued:

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 substances, 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 purposes of dissolving the gum applied as aforesaid, the surface is exposed to the vapour of water, or left for a short time exposed to the direct rays of the sun. After the gum is dissolved, the varnish is applied to the article, and the varnish and composition are transferred as before; and the colouring medium or varnish is then applied 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, paper maché, or cell-lace, &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 varnishing, polishing, &c., as described.

For producing designs and patterns in burnished gold or silver, gold or silver leaf is first applied by means of the ordinary gilding or silvering water, or in such manner as to cause it to adhere sufficiently to the surface of the article to be ornamented. A design or pattern, or composition, consisting of 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 naphtha or other solvent, when it will separate from the gold or silver leaf.

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; if any agent is then used to bite off or remove the gold or silver from those parts not protected by the transferred impression, the varnish is removed by washing with spirit or other solvent.

For the purpose of ornamenting marble, wood, &c., impressions, or designs, are transferred to the surface 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 gilding or silvering, as required.

The patentee claims the method of forming designs and patterns upon paper-maché, japanned iron, glass, metal, and other surfaces, by printing any required design or pattern in an adhesive mortar or composition; which design or pattern, so produced, is transferred to the surface or composition, and the operation is then proceeded with as before, 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, or which have been transferred and the leaf or powder for burning-in was rubbed into or applied on it; whether colours in the state of powders, or metallic powders, 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, PATENTS, AUGUST 18, 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 plains 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 more of the available strength of the conductor, at a weight consistent with sufficient strength, but also the fullest amount of electrical conductance.

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 wire or rod, or what is preferable, a rope or strand of wire, which shall form 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 one-cotton wires, and what is employed for the purpose is a compound of caoutchouc, sulphur, and coal-tar, or other similar substances, baked hard, and resembling in appearance the material manufactured according to the invention of Mr. Goodey, for which letters patent for England were granted to Moses Poole, the 16th September 1852, and which itself might be employed with the modifications and substitutions. 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 of 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 wires, 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 submarine telegraphs, but which may also be used for submarine purposes). The conductors are insulated in the arrangement that on the outer end of the conductor there is a set of the form or dice 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 insulating material, but to cover the whole with the same material in any number of wires at one operation, and all conjoined in one rope. For this
purposes, in the die-piece are placed two or three hollow mandrels (according to the number of openings), 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 mandrels 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 month-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 wire, or of wires of different metals (insulated or otherwise) for submarine and under-sea telegraphs; 2. The mode of insulating several wires at one operation, as hereinbefore described.

BOARING ROCKS FOR BLASTING.
HENRY KRAUT, Patentee, September 15, 1853.

This invention consists in an improved tool or borer for cutting out a chamber or the bottom of the hole made by the common borer generally used for blasting; which chamber is intended to receive the powder or other explosive agent.

In the annexed engraving, 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 borer, 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.

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 the carriage movements of the carriages behind the engine act 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, 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 silicates, 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 such process. According to the 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 silicates 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. Thearticles 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.

![Truss Bridge Diagram]

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 brace, 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 F, F, at the bottom of the gothic-arch braces—on each side, and secured thereto by bolts. The upper chords of the bridge are applied to the tabs 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 screws beneath them, and 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 increase 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."

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 Pescow 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 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 his residence, whereas all former Grand Dukes had lived in wooden houses. It was called the Hewn Palace (granatowolja 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 da Italia, who had for his assistant another of his countrymen, named Peter Antionio, 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 Alojzio, which was called Dvorec Terassy, 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 1483, and also cast balls. 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 smiting of Mathias Corvinus, of Hungary, and obtained miners and engineers from thence, as well as from the Emperors 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.

* From the 'Scientific American.'
The central portion of the tower, which comprises the pipe or tank into which the water is forced, is 5 feet in diameter and 100 feet high, and is made of cast-iron varying in thickness from $\frac{3}{4}$-inch at the bottom to $\frac{1}{4}$-inch at the top. The bottom of the pipe is riveted to a circular flange 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, 15 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 circular, 15 feet across, and has a circular opening inside 9 ft. 6 in. in diameter, thus leaving a space of 3 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 stone-work) serve the double purpose of connecting the ironwork and masonry tanks 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 23 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 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.
ON THE MOTION OF WATER THROUGH PIPES.

By Henry Hensley, 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 works of that city. A memoir detailing the methods of experiment, and the results obtained, has 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 economical 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 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 cast iron, some of wrought iron, and some of iron sheeted with pitch, or of smooth glass, some of cast-iron pipes, some of them quite new, some old, and with and without deposits, some of them on one of their sides, to which the steps are separately bolted. To the exterior water pipes, and between the cluster columns, are secured a series of castings, which are so shaped as to represent a continuous Gothic scroll railing. These pieces are further cemented 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 water pipes and hand-rails, secured in this manner, serve as diagonal braces for the cluster columns. The stairway terminates at an octagonal landing 17 ft. across, which is composed of plates laid on radiating cast-iron beams, one 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 146 ft., and to the landing 114 ft. 8 in., the latter being reached by a flight of 173 steps. This altitude, together with the whole structure being set at a very high level, on 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 Philadelphia Waterworks, which will be completed in the autumn of this year, are on the direct-action Corliss, with two sets, both with Burkitt'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.

R being the mean radius or hydraulic mean depth, v the inclination of the tube due to the resistance, A 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 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 of unequal radius.

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 pipes 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 stood in the ratio of from about 55 ft. 9 in. to 65 ft. 4 in., and again from about 73 ft. to 131 ft., 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 confirm the important hydraulic law long most reluctantly admitted.

In order to determine the numerical values of the constants A and B in the formula:

\[ v^2 + v A = R I \]

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-
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 modes; 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 formula, 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 dimeters, the formula of resistance may be changed to

\[ \varepsilon R = R I, \]

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 surface, 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, 7/17, 7/49, and 5/65, gave for \( R I \) values which varied from 1 to 3. This result shows that in estimating the action of a series of pipes for waterworks, 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 \( B_2 \) 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

\[ R T = \varepsilon (a + \frac{b}{R}). \]

Or if \( L \) represent the length of the pipe and \( H \) the height due to the resistance,

\[ H = \varepsilon \frac{L}{R} (a + \frac{b}{R}). \]

From a series of 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 0.129 metre M. Darcy has obtained the following mean values:

\[ a = 0.000507, \quad b = 0.0000647. \]

When the values of \( R I \) and \( e \) are given in English feet—

\[ a = 0.000507, \quad b = 0.0006182. \]

The expression generally recognised among hydraulic engineers as equivalent to the foregoing, is given by Mr. Neville in the form,†

\[ R T = \varepsilon (a + \frac{b}{v^2}). \]

Where

\[ a = 0.0006565, \quad b = 0.0000689. \]

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 \( B_2 \) in the formula of \( \varepsilon R = R I \), for all diameters, for every centimetre from the first up to 50, or half a metre, and also for every 3 centimetres up to a metre. By simple transformations of the preceding formulae, 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 inconsistency, 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 \( R \) 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 pressures 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 from the with the square roots of the inclinations, it followed:

1. That the initial of this excess to the inclinations was constant.
2. That the ratio of this excess to the 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 \( \frac{1}{\sqrt{R}} \) for the same pipe, varies from one pipe to another inversely as the radius, so that \( K \frac{1}{R} \) 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

\[ V = v = K \frac{1}{\sqrt{R}}. \]

Whereas, if \( \omega \) represent the velocity of a particle at the surface of the pipe,

\[ \omega = V = K \sqrt{\frac{1}{R}} \text{ or } K \sqrt{\frac{1}{R}} = \frac{V - w}{\sqrt{R}}. \]

Hence substituting, we obtain,

\[ v = V - (V - \omega) \frac{r}{\sqrt{R}}. \]

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. Poiselet, 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 orifice, and the velocity. It follows, therefore, that the coefficient of contraction at the origin of the pipe ought itself to vary with those 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 published in detail by the Academy of Sciences, in the 'Mémoires des Savants Etrangers.'
THE USE OF COAL IN LOCOMOTIVE ENGINES.

REPORT OF MOSER, 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 com-
mittee 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 Moser, 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
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 com-
pleting 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 "Blacker" class.

The Blacker coal seemed to be most eligible for use on the
southern division; on account of its being procurable at a com-
paratively low price, in consequence of the proximity of the pits
to the main line of the southern division.

The pits are situated on the Coventry and Nuneaton branch,
about four miles from Coventry, and yield a coal of hard quality,
free from any excess of vitrifiable matter; and, in other
as, 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 from
small coal, and the coal turned "screenings," or "cobblies," which
is delivered in small lumps, but free from dust or slack. The
priced, as given to us by Mr. M'Connell, are:

Main coal, delivered in contractor's
wagon at Rugby .......................... 8s. 7d. per ton.
Cobblies ditto............................ 7s. 9d. ditto.

The cobblies are nearly as hard as the main coal, and break into
caller fragments when struck by the
hammer.

The cobblies 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 four days' work with the best coke we could obtain—viz.,
Pease's West coke.

The engine worked alternate days with coke and coal, per-
forming each day 1844 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 would have given them.

For six consecutive days (the Sunday excepted) the passenger
engine No. 303, Mr. M'Connell's patent, worked the 12.30 p.m.
up express train, and the 8.45 p.m. down train, three days with
Pease's West coke, and three with the Hawkesbury main coal;
these two coals 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:

<table>
<thead>
<tr>
<th>Series</th>
<th>Description of Fuel</th>
<th>Miles run</th>
<th>Average Load Carriages</th>
<th>Average Speed per Hour</th>
<th>Fuel consumed per mile</th>
<th>Water evaporated per lb. fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Coke</td>
<td>144</td>
<td>24</td>
<td>24</td>
<td>6,300</td>
<td>6,000</td>
</tr>
<tr>
<td>B</td>
<td>Coal</td>
<td>144</td>
<td>32</td>
<td>28</td>
<td>6,300</td>
<td>6,000</td>
</tr>
</tbody>
</table>

The remaining experiments have to be reduced with one of
the largest class of the ordinary engines, No. 293, working the
12.30 p.m. up, and 8.45 p.m. down trains, with Hawkesbury main
coke. The engine has a large fire-box with a longitudinal mid-
feather and two fire-doors.

<table>
<thead>
<tr>
<th>Series</th>
<th>Description of Fuel</th>
<th>Miles run</th>
<th>Average Load Carriages</th>
<th>Average Speed per Hour</th>
<th>Fuel consumed per mile</th>
<th>Water evaporated per lb. fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Main coal</td>
<td>141</td>
<td>32</td>
<td>28</td>
<td>6,000</td>
<td>6,000</td>
</tr>
</tbody>
</table>

I. The question of the practicability of burning coal in such
locomotives must be answered in the affirmative. The engine
had no difficulty in maintaining the required pressure of steam
and speed with the trains assigned to it.

II. Taking a general view of all the performances of the engine
No. 303 with coal, the consumption, or rather non-produc-
tion 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 light-
ing 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,
and not during the start of a fire, 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.

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 smoke is enabled to pass through the ignited fuel under a
moderate draught.

2. Frequent firing in small quantities to equalise the dis-
gagement 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 a 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.

3. 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 keep-

5. The combustion chamber allows of the mixture of the
gaseous products of the two fires with the quantity of free
oxygen necessary 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.
6. 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 into a fire. The free air space 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 cinder.

6. Damper, to regulate admission of air to the grate, must be capable of being adjusted 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 tinge of smoke was present, 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 fire altogether different from that of a coke fire.

We state 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 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 lb. water; | 1 lb. coal to 8 lb. water;
which show a proportion of 100 lb. coke as equivalent to 140 lb. coal, as consumed in No. 303 engine.

We shall assume 45 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 well 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 25 per cent., the evaporation being 1 lb. of water per lb. of coke, and 0.75 lb. of ditto per lb. of coal.

IV. Relative economy in cost of fuel.

The cost of the Hawksbury Main coal being assumed at 9s. 7d. per ton, and the price of Pease's West coke at 21s. 9d. per ton, which is the contract price for the same delivered at Hugby in the contractor's wagons, we may estimate that the cost of the fuel here experienced is equivalent to coal at 2s. 1d. per ton, will be 3s. 4d. being 9s. 7d. increased by 48 per cent.

Out of the 21s. 9d. 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 1s. 6d. per ton, which reduces the cost to Company to 2s. 3d. per ton.

The saving by use of coal would then be 3s. 4d. per ton, or the difference between 21s. and 1s. 6d.

Upon an annual total consumption of, say 74,000 tons on the southern division, the saving to locomotive power would be £2,478 from this cause.

But, however, assuming 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 on which coal can be practically used without occasioning a nuisance, and these constitute at present but a small proportion of the total 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 be pressing.

The question is, in our opinion, one 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 traffic 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, O.M.E., M.P.

My Lord—I have been duly honoured with the acknowledgment 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 does not propose the removal of the injury resulting to the inhabitants, but to spend 1,000,000l. in covering over a naturally-formed rivulet, masseterising 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, by deputations to the House of Commons and Westminster, 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 700 millions of gallons of sewage daily, and would cost 1,000,000l.

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 26, 1848; and subsequently received assurance of support, March 31, 1848; their comprehensive character being acknowledged by the Metropolitan Commission, by resolutions, March 8, 1848, by report to the House of Commons, 1841, and by the resignation of the Commissioners when they were unable to carry them into execution, June 23, 1842.

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 enterprises, 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 5th March, 1855, and subsequently.

S. S. MORREWOOD.

Islington, July 21st, 1854.
HINTS ON THE NEW, STEAM, FREGATES FOR THE UNITED STATES.

By J. M. Rowland, C.E., Niagara.

It is announced that Chief Engineer Martin is going to Europe to examine naval machinery, with a view of introducing some improvements into 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 justify to the progressive spirit of the age. The following remarks are respectfully submitted to the consideration of those who will be interested in 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 Conmed 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 Conmed line I have not been able to determine. The power of this line, with 25-inch cylinders, 16 feet stroke, cut-off at 40.4 min., 280 pounds in the boiler, 26 lb. in the cylinders, 4 lb. vacuums, 14 revolutions per minute, may be rated at 1,800 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. L. H., was 11.24 knots. The consumption of coal per voyage 849 tons, and per hour 728 lbs. This makes the consumption of I-horse-power per hour 485 lbs. really a very creditable result. The average evaporative power of the boiler is stated to be 72 l.b. of water of 110° by 1 lb. of anthracite. Looking at these facts, the apparent to be left for 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-fashined mode of feeding water was adopted in the Collins' line, while such an excellent apparatus as Pissaro's Condenser could have been employed. 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 premise 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 Cornwall engines successfully carried out in these new frigates. I propose to carry steam of 60 lb. pressure, or say 45 lb. above the atmosphere, the plan of the Collins' engines being 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 these cranks set at an angle of 120°, in place of two, and 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 just-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 competent to judge on that point. Steam-engines and boilers are my province, where I may venture my 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 hasten myself that this opinion will be considered 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 Cornwall engines have attracted much attention outside of the small district where it has been established fact for many years. The system is now generally performed in North America, and pumping-engines which are driving 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 this number added to I, 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:

<table>
<thead>
<tr>
<th>Fraction of Stroke</th>
<th>Expansive Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-half</td>
<td>2.38</td>
</tr>
<tr>
<td>One-quarter</td>
<td>2.53</td>
</tr>
<tr>
<td>One-eighth</td>
<td>2.63</td>
</tr>
</tbody>
</table>

This gives the effect of half-stroke

The full stroke being represented by 2.000000

The effect of quarter stroke is 2.38

The effect of one-eighth stroke is 2.63

Now let us represent the effect of full stroke with full pressure by 1.000000

The effect of half-stroke will be 0.58

quarter stroke 0.59

cut-off at one-eighth 0.58

And also, if one ton of coal at full stroke produces an effect represented by 1.000000

Ditto cut-off at one-half 0.58

Ditto one-quarter 0.59

Ditto one-eighth 0.58

And further, if a voyage to Liverpool, using steam without expansion, will consume 1900 tons. The consumption at half-stroke will be 1000 tons

quarter-stroke 700 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 800 tons at quarter-stroke, 700 tons at half-stroke, and 1900 tons at half-stroke. Here, then, is a wide field—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 the result of the action of 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 enameled 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 expansion.

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 a 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 we provide three times the ordinary allowance for sea-bottles carrying 13 lb. above the atmosphere, we can carry 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-bottles. Our steam-boat men in the West laugh at the idea of 45 lb. being called high-pressure. They have frequent explosions, and are fearful of the recklessness in the management, by our own people, 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, 160 lb. per square inch upon the safety-valve in boilers of 45 lb. above, and yet no new. This is equivalent to an absolute force of 15,180 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
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 large allowance of strength above that of the wrought Pressures of Europe, because 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 placing of cutting off at one-eighth of the stroke, cut off at half stroke in time of 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 its 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 Arctie have 9-inch bore and 16-feet stroke; this makes a cross of the piston 7086 square inches, the pressure at 191 lb. and the velocity at 134,673 lb., and the momentum of a 10-foot stroke, 1,346,730 lb. Assuming the pressure of 25 lb. effective per inch, we find the momentum of one superfluous inch of piston, acting at full pressure throughout the stroke of 10 feet, 58 x 10 = 580. To produce the effect of one-pair of cylinders, an equal in momentum to 1,346,730 = 2067 square inches. And in order to cut off at one-eighth of the stroke, the enlarged size of the piston will be found at 2967 : x : 3085 : 1000, or x = 6927 square inches. Of a piston of 6927 square inches, equal to 1817 pounds, cutting off 80% of its circumference and 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 - 2 = 4618 square inches, or 76" inches diameter and 10 feet stroke. The strength of cylinders and balance of machinery must be increased over that of the Arctie to meet the greater pressure of the steam when admitted.

ON MARINE BOILERS.

By J. A. ROBERTS, 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 combine with carbon, the result will be carbonic oxides, a product of imperfect combustion. A certain supply of atmospheric air, therefore, is necessary. But this supply may be too copious or too scanty, 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—anthracites and bituminous—as fit for ocean steaming. It is not my intention here to analyze these varieties; I only mention them here 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 bimetallic 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 gives a powerful blast, while the draught of a soft coal furnace would be very strong.

Experience has yet set the most economical speed of consumption of mineral coals. Water's rule was to allow one superfluous foot of grate surface for every ten superfluous 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 in steamers. The boilers of the Arctic contain 53 feet of grate for 1184 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 Collins' steamers, the Arctie, prepared for the Marine Institute, appears to be reliable, the average consumption of anthracite during six trips was 1379 lb. per 1000 miles for each foot of grate. In boilers of this type, during construction the insertion of the grate a few inches from the front, so that the webs of soft coal would be a fair assumption.

Chamisea, who has 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 much larger scale will show, that evaporation is more than 9 lb. to 10 lb. the boilers of the Arctic, during those six trips, evaporated 74 lb. of steam from water of 110°F to 1 lb. of anthracite, and this is one of the highest results that have been obtained in the regular working of marine boilers. It is evident, therefore, that there is room left for improvement. There is still a waste of fuel, which arises from imperfect combustion, the result of a faulty construction, and no doubt in part is attributable to imperfect stoking. Much of trouble 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 the construction of marine 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 rate, 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? Most certainly not; a furnace would be a mass of carbon, in which, 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 eminently 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 must generally arise 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 relieve the flames 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 inferior surfaces 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 processes of combustion and of the laws from the various effects 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-
centred 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., 3,000 lb. of anthracite are consumed in ten hours for the heating of 18,000 lb. of charcoal hammereds 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 134 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 blast.

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 streams where the gases become thoroughly mixed and fully ignited before their caloric is expanded 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 36 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 greatly on 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 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 flue, 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 fire 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 neglected. By the above remarks, I have only attempted to direct attention to points which are not generally recognized, 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.

As concerns the subject of artificial draught, I am satisfied, based on 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 22, 1854.

FIG. 1.

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, c, 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, whereby forming an inclined projecting lip L, under which the flanges a, 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, c, 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 thus 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 stone, the top stone is placed over them and caused to fit in its slot E. After this is done, the key e, or its equivalent, which passes through the hole B, in the top stone, is driven between them, and they are forced apart, which causes the flanges to fit snugly and securely under the inclined projecting lip 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 dovetail, 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 horizontal 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.'

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 architects. The American government, by an act of Congress, purchased a piece of land in the 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 organized, on account of the political relations and supposed subject 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 favor in this country; but the 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 at the rate of 60 cent per day, 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 for the Exhibition of 1853; 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 wife 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 respectable character. Upon these, reports have been drawn up by the English commissioners, and which have been already 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. Cartsesen and Gildermeister, of Hamburg, and a great number of Englishmen and foreign engineers 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 Hamburger, but several of whose assistants were native citizens. The examiners were of foreign origin. The want of the independent organisation, and of the undertaking being intrusted to foreigners, was that, as usual among Germans, they quarrelled among themselves, and Messrs. Cartsessen and Gildemeister, the authors of the chronicle of the Palace, lay the blame on Mr. Detmold, while the latter put the responsibility 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 expose their dissatisfaction with each other. As to the accusation 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 always 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; and, at a future period, they were told to proceed with it, which they could only do by sacrificing to a great extent. Then the contracts were let after the same fashion; and as the prices 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 do it successfully in Industry. It is an art on a large 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. Cartsessen and Gildemeister have settled as architects in the design worthy of the situation. Providence to the extent of 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. It will reach the most critical part of the present day's 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. We shall receive the praise 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 the State of New York, requiring an Association to undertake the Exhibition of the Industry of the free and independent nations, a committee having been organized, 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 left to the co-operation of Prince Albert and the committee was purely accidental. We did not know of the lease being open until about three weeks before the final arrangement, when, at the suggestion of our friends, we undertook the task of furnishing a design worthy of the situation. We consulted the 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, and the plan was manifested to consist of a speculative rather than a national undertaking, and European states were cautious in giving any promise of co-operation. The committee, therefore, thought it advisable to reserve their expenditure for the accommodation of 17,900 square feet, - the area of one story building, which should embrace as much as possible of the ground allotted to them in Reservoir-square. If the reader refers to the correspondence with the Board on this subject it will be seen that we forborne to mention these expenses, although they were specified in the original plan. An 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) 92,000 square feet more than they imagined it was to cost 2,000,000 dollars, whereas the building as finally executed cost only 1,200,000 dollars, after expenses on the erection of the somewhat unsightly machine arcade. The pecuniary loss 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 opened the crowded effect of many of its departments, can conceive how very much the public are bound to pay for the building, once it is in an architectural point of view. We hope that the authors of the present work, Messrs. Cartsessen and Gildemeister, have avoided the errores of their predecessors, in following the example of the Exposition of 1851, and that the finished work will be an effective recognition of the excellence of American architecture."

The architects have devoted the largest part of their attention to the Exhibition in America, and have, we believe, been the more in the habit of following the example of the first. We have endeavored to follow the example of the first, and we believe, been the more in the habit of following the example of the first.
Elegance to the whole structure, an open court in the centre, faced in with canvas. Even the unprofessional reader can easily realize the effect of so flat and meagre an edifice, when so closely contrasted with the huge proportions of the Reservoir.

Our article was approved by the Board of Directors, and those alterations having been carried out which the smallness of capital of the company rendered unavoidable, our contract was signed on the 26th of August, 1852, after which the mechanical departments were commenced. The contracts for the masonry were given out or 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 previous report on this work was rendered by the superintendents 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. The introduction 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.

The idea after 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 machinery, and it became of course a natural necessity to keep them continually occupied in making 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 undelivered of for some weeks and months, either because the work was 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 milled-iron tenon which was given to the cast-iron work interfered so much with the process of the wrought-iron work, that the bars were 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 superintendent.

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 function of the contract, we took no measures of 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 contracts we were compelled to go to the most intractable expeditors to get materials together; we had to search far and wide for materials to store for angle-irons, making what use we best could of such pieces as we were able to procure in this debilitary manner, completely reversing the usual order of the working, and building up 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:

1. 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 louvers, 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 guttering was presented, putting the same material in a new way, and the building under the control of the contractor. The end obtained by this alteration from the original plan did not prove to be quite so satisfactory as the directors had anticipated.

2. In regard to the windows placed over the louvres to prevent the leakage of storm-bronze cupola of the following manner: 1. They that spoil the appearance of the building, and prevent proper ventilation.

3. That they have not cost too much in time and expense.

4. That they did not fulfill their purpose, which was proved by the first heavy showers of rain, we feel convinced that they would have been 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 superintendent, we consented to the substitution with the express understanding that they would be affixed to frames, 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. Hatty Lewis, the architect of the Panopticon, as expressed by him in a letter to the British Architects. Messrs. Carstenson and Gildemeister observe:

"We cannot omit here to remark that the unattractiveness 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 execution of the work, which we should not have done if we had not been convinced that the superintendents of the building, with the explicit consent of the Board, entirely completed at the opening of the exhibition.

For the decoration of the dome we had designed two designs, besides the one adopted in the building, and one suitably fitted for the dome, 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 shining through and spreading beneath the superimposed 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 superintendent of Mr. Greenough, the result can not be said to be satisfactory, 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 Obscure 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.

At one time we understood that a gentleman from England, Mr. Mould, a pupil of Mr. Owen Jones, offered some curious designs for the decoration of the building, which were rejected by the Executive, and, after lying in our office for some seven months until 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 share in the affair; nor do we ascribe any blame to the Board, for we are satisfied that the reader, after a perusal of this statement, and the accompanying correspondence, will see that whatever mistakes may have occurred 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 pillars, columns, arches, girders, cornices, towers, &c. The projecting parts of the moulings to be kept with a lighter shade, and on some of the receding parts with a darker shade of the same standard. The columns and brackets on the window arches, ornaments over cornice, tower railings, &c., to be gilt; or painted with a colour substituted for gilding.

The lead and orange trims of the windows 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.

All the louvres of the roof 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 outdoor railings with a brown patina, to be painted with the same metal and lamps relighted 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 purple stripes. After bays, the piers of the arches to be painted with positive colours, and gilding according to principles existing for more obscure decorations. The construction of the roofs, as standards, braces, needles, purines, ribs, tie-rods, trusses, &c., with a deep azure.
The Civil Engineer and Architect's Journal.

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, bolted 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, and was then removed to its place. The contractors for the work 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 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 movable 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 makes all the advantages of the last.

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 annoyance, chiefly in winter time for instance, in case of heavy snow."
imperfect insulation of the conducting-wire from the water, the attractive power of the magnet contained, notwithstanding that the circuit was broken, was sufficient to keep the wires connected and to establish a magnetic connection between the two by means of a wire. This wire 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 was deposited, and several 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 combinations of numerals are made for certain 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 acted upon, 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. The inscriptions of numerals on this plate, 70, shall appear through openings ranging in a horizontal line in the face of a 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 inscriptions on the dial-plate of the apparatus. In the construction 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 Boulogne line, by the direction of Dr. Dujardin, of Lille, which consisted of a transmitting and a receiving instrument, actuated by magnetoelectric 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 axis, in a manner similar to that of Mr. Bain. On this drum was stretched the paper to be acted upon. An electro-magnet was placed 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 acting at the lower edge of the drum, 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 electro-magnet beneath the drum, the pen was strongly repelled, which caused the pen to rise from the trough of ink, and 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.

Next comes the printing telegraph of Mr. E. Hughes, which is worked in the United States to a considerable extent. Mr. Hughes 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 Hughes's invention was entitled to protection. 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 composing instrument and the mechanical elements of 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, inclined 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 setting against the inner surface of the circuit-wheel. This friction contrivance aids the revolution of the shaft, whilst the movement of the cylinder must be arranged to be certain teeth of a wheel, placed at one end of the cylinder, and is divided into twenty-eights 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 within the frame, and one to any part of the frame, which presses on the circumference of the circuit-wheel; so that 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 a corresponding set of stops, arranged around the cylinder, which has the effect of keeping the circuit either broken or closed, according as either tooth or 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 the current, the magnetic digits of 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 movable magnets down to the fixed ones, which breaks the current, when again the spring rises to press 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 letters, is carried on the frame, and is actuated by the type-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-twelfth of a second; three hundred letters, in the form of Roman numerals, can be transmitted in the second. When the magnet is in a position to transmit a message, a current is sent to the printing apparatus, the motive power is thrown into action, and the machine is set in motion; the messages are printed per
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, acts 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, and is independent of 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 failing. The intervals of time the electric current of heat, generated or consumed, 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 C 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.

For 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.

The first and simplest 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.

In G. Cook's telegraph, patented in 1849, the band is 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 Meares, 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 to 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 the agents of communication are drawn from the same magnet, and single or double currents may be sent through any number of instruments at different stations; fourthly, an improved arrangement 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 apparatus 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 reserving timekeepers, either primary or standard clock, which need not be added here.

Henley's telegraph was experimented with by the French government on the line of railway from Paris to Valenciennes, a distance of 100 miles. The wires were connected so as to trouble the telegraph offices at 340 stations. Unfortunately, his apparatus has 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 by a current produced with the assistance of the friction of the rollers. 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 an engine, operated 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 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; such as the metal spiral magnets, actuated 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 electric 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 apparatus.

In June 1850, G. H. Horn proposed a telegraphical scheme, 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. The instrument required a cylinder or disc of soft iron, 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 heating 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-colored mark.

In the same year, patented, by Thomas Allan, of Edinburgh, a method of applying 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 couples, of convenient size, permitting the ends or poles of electromagnets 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 Ersted, and the experiments of Winkler, Lemonnier, and others, down to the present systems of Wheatstone, Morse, Henry, Brett, and many others, whose ingenious instruments, actuated by the 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 improvements of the electric current to compose or form new chemical combinations. These we have left an open question, and have merely stated the facts, the history of the subject, the 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 extent of telegraphic line of any country in Europe. The telegraphic wire, made for the transmission of messages in America, has been so far extended as to form a true system of communication, and the whole of the United States are covered with a network of wires, which extend for a distance of about 6,000 miles. The routes selected by the committees for this line, according to the survey of Capt. W. W. W. W., 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 one of 2,000 miles, and consequently be entirely free from the great difficulties to be encountered, owing to the snow and ice on the northern part of the line, which is in the vicinity of the snow and ice near the mountains in latitude 36°. This Pacific Telegraph Company is now fully organized, with Mr. H. O'Reilly, the projector of the scheme, as president, and Mr. T. F. Sharp as secretary, with a capital of $5,000,000.

The telegraph lines in America are of a length which, from the limited extent of our islands, are unknown in this country; as, for instance, the two southern lines, one from Cleveland to New Orleans by Cincinnati, 1,000 miles long, the other from Washington to New Orleans, by Fredericktown, Charles-town, Savannah, and New Orleans, which is 1,700 miles in length; this line has been extended west to Independence, Missouri. The entire length of telegraphic line from New York to New Orleans, and Charleston, is 1,866 miles, which 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 adopted in New York and Erie, and Michigan, New York to Milwaukee, and New Orleans lines, with perfect success. The total number of miles of telegraphic wires in the United States amounted, up to the returns of last year, 9,376 miles, of which 18,000 miles are worked with Morse's instrument, and the remainder with those of House; and 3013 miles with Bain's apparatus.

After America, England possesses the greatest extent of telegraphic line, which are estimated by Dr. Turnbull at 2385 miles, but as this number represents the length of railway lines, and not the total length of telegraphic 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 9992 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 given above 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 Jacob Brett and Little. Bain's electro-chemical telegraphic wires, extending 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 the lines of the rail-road; but one wire is sufficient, and the instruments by which the signals are transmitted and recorded are those of Siemens and Haloke, Kramer, and Morse.

The total length of wires radiating from Berlin is estimated at 1483 miles. The Austrian telegraph extends over a length of 1082 miles principally employing the apparatus of Morse, modified by Robinson; of Bain, modified by Eiklig; and those of Bierer and Stoehrius.

Owing chiefly to the government surveillance over the telegraph in France, and the high tariff charged, France is considered a less popular means of communication. The extent of telegraphic communication in France is in proportion to the extent of the country. The latest returns give no more than 700 miles of electric accommodation, on which the instruments of Brest and Foy are generally employed, together with those of Wheatstone, Dufard, and Gardinier. Brett's apparatus is used on the line connecting Paris, Rennes, Dijon, 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 535 miles, and in Bavaria over about 450 miles, and are principally worked by Stoehr's needle instrument and his bell apparatus. The Tunisian lines of wire amount to about 333 miles in length, the telegraphic apparatus being furnished by Brest 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 Madras, 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 increases 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 6800 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 afoot, and many of them in construction, in which far greater distances are embraced, and more gigantic difficulties are encountered, than those of Prussia, Austria, France, Russia, and other countries, are being rapidly brought into connection, and are gradually converging towards our own island, with which, before long, they will be in direct communication.

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 expense or previous

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
SEPULCHRAL MONUMENTS OF THE CEMETERY OF BONN.

Many of the sepulchral stones of the famous Rhine University possess not only a historical, but also an artistic importance. Here the very prodigiously custom of placing faithful counterparts on the graves of the good and illustrious has been most resorted to, as, for the acute observer, the physiognomy of man is perhaps his best biography. Besides this, when as shown in his old tombstone as exceedingly well executed, the monument being erected by King Frederic William IV. to his former tutor and teacher. Although the memorial tablets of W. A. Schlegel is much more simple, the bronze bust is one of great resemblance, exhibiting a noble cut of head, with a brow beautiful, formed by many a deep thought. Another monument is that of M. de Balzac, 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 regicde, Idelisborn, 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 mercurial hillehead itself. Maltese Semser and others of a pair of great men. His fine dwelling, replete with master-paintings of every school, belongs new to the surviving brother, Selphis Boiser, but being of a more eccentric character, he does not receive those numerous foreign guests who formerly thronged to this place of perfection. 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 sinner and well-grounded endavour.

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 Ptolemy architecture. It was as early as 1144, that Henry II. of Babenberg (called Jasomhopp, Duke of Austria) erected, on the ruin 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 Octavias Falkner, a master mason of Cracow, who built this primimal 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 side, and the whole of the interior of the nave are buttressed. In the exterior, the pyramids of the two exterior steeples exhibit already traces of the style of the Ptolemy 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 1360, 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 put in the interior, and the vast building were made by U. Helbig, H. Kumpf, 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 never completed, only complete is the tower and covered with a copper roofing in 1709. The whole length of the completed steeple is 435 ft. 6 in.; the whole length of the Cathedral 343 feet; the width of the middle nave between the pillars (of 8 feet thickness), is 234 feet; that of the lateral nave, between the height of the middle aisles, was 144 feet.

As the completed steeples lay on the southern facade, it is this which presents the finest view of the building, and the richness of ornament is most apparent, which had just taken hold of Gothic architecture when St. Stephen's, of Vienna, was built. Very richly ornamented were the large windows between them; arched vaults, with all the finery of medieval art, extend before the doors; and the steeples, reaching
far into the skies, presents numberless finials, like stone carvings. It must be remembered that of and four steep gables, which project over the height of the walls, only that on the west side was completed—probably by Puchhauem, in 1430. This has a perforated pediment, which, beginning above a straight gallery, presents below three collateral gables, above which rise 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.

CHAMPIONS 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, skeletonized 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-open 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 termus of the bridge to the lower termus 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.

In this system, in which the principles of the lever are analyzed, and skeletonized—as by placing the crush resistances on the under side, and the stretch or tension resistances 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 the dissenting 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 suspenders. 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 L of Lusignan, by Archbishop Albert, and finished in 1388, 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, show that it was of a stern symmetrical character 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 the church in 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 transverse naves, which are one-third the size of the principal nave, the form of a Latin cross. The front is forty metres broad, its exterior length is seventy metres.

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 by their successors, and 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 be assigned to the right or termination of this hall, which, however, is met with in all Frank churches of the island. It may be, that in those primeval 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 these sculptured compartments 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 ferns. The towers have on 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 metres 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 arcades, a niche is cut out. Above the doors are four three small arched openings, which represent 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 is built in four arches, and has a garland of roses in alto-relievo. Each of these secondary archivolts reposes on a broad leaf, which much resembles a species of armum, a plant to be met with in Cyprus. The inner portion of the arcade is ornamented with girdans in baso-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 form and the rules of art. There, yet, everything seems to have been deeply calm and majestic, owing has its determined plan, and the aspect of those structures was most cheerful and pleasing, notwithstanding the sternness of character which pervaded them.

In its ensemble the Cathedral of Sta. Sophia of Nikosia forms a church, 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 apera, which has buttresses like the nave, is pierced by long windows. Over each of the naves runs a tower of about thirty metres, the church; further above, a second platform reaches over the 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 metres 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 part is a cave, 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 is formerly occupied by a large octagonal tower, which, when 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 apses 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 metres broad; the lateral naves ten metres broad, perpendicular to these.

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, baptistry, &c. Under the masts and carpet— which with the Turks have covered the whole area—parts of the old stone-works, 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, of which ivy and vines are projecting. Their ornamentation resembles that of the Corinthian, but the whole composition gives a tendency towards the antique is unmistakable. 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 wall 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 it did not have an idea that 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 the greater 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 has been put on recently, or at least renewed; but whether under their present covering another coat of paint exists, could not be ascertained.

* From the "Allographic Manuscript."
LIGHTNING CONDUCTORS FOR SHIPS.*
By R. B. Forres.

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, and in some of the other navies in 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 ship-building.

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 

\[ \frac{1}{2} \text{inch} \] in diameter, is good as far as goes, and the same may be said of a wire not 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 fail in the operation, leaving the mast unproctected. 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.

The Ordnance Survey, Ireland.—Colonel Hall, R.P., the head of the Ordnance Survey, has been succeeded by Major James at Scarrmarron. Colonel Parker, a grandson of the famous Enчикkeen, having retired, Captain Leach, now stationed in the Belfast, succeeds him. Captain Barlow, from Ennhilken, succeeds Captain Leach in Belfast. Lieutenant Parsons, from Glasgow, succeeds Captain Barlow at Ennhilken. 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 £200 a year. There were thirty-two applicants.

Río de Janeiro.—Mr. W. G. Clout, formerly the Engineer and Manager of the Hydro-Carbon Gas Company, in Manchester, has since his arrival in Río de Janeiro (to which city he went as Engineer to the Río 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 Prata 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 30 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 13 feet long, bound in bundles one foot thick, which are so ingeniously arranged and tied, that it is impossible for sand to wash 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. Leveredge, 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 recommendations 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 PATENTS GRANTED UNDER THE PATENT LAW AMENDMENT ACT.

<table>
<thead>
<tr>
<th>Patent No.</th>
<th>Invention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1044</td>
<td>Improvements in compound steam-engines</td>
</tr>
<tr>
<td>1112</td>
<td>Improved construction of bread for baking machines</td>
</tr>
<tr>
<td>1117</td>
<td>Improvements in the manufacture of articles of leather under clothing</td>
</tr>
<tr>
<td>1189</td>
<td>Improvements in the manufacture of mangers and troughs for horses</td>
</tr>
<tr>
<td>1288</td>
<td>Application of a new material or fabric to the manufacture of plasters for medical or surgical purposes</td>
</tr>
<tr>
<td>1292</td>
<td>Improvements in the manufacture of starch, applicable to part of the sizing of colours and other substances held in solution or suspension</td>
</tr>
<tr>
<td>1360</td>
<td>Improvements in the manufacture of insecticides and other substances</td>
</tr>
<tr>
<td>1381</td>
<td>Improved method of roofing or covering buildings, reservoirs, and other spaces requiring roofs or coverings</td>
</tr>
</tbody>
</table>

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 £200 per annum; and Mr. J. C. Campbell, barrister-at-law, Assistant-Secretary, at £600. Mr. R. Rawlinson, Consulting Engineer, at £600; Mr. Rammall 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.

* From the "Scientific American."
KIDDERMINSTER BATHS AND WASHER-HOUSERS.

(With an Engraving, Plate XXXIII.)

The borough of Kidderminster contains a population of something under 30,000 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 Whitchurch, as architects.

We have much pleasure in directing public attention to this building, in which provision has been made 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 and all. 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 has an entrance. This part of the establishment is on a small scale. The detail of the arrangements comprises all those improved matters which experience has suggested. The baths are of porcelain (glazed), and the divisions of the baths of slabs slate; in short, all those little matters have been strictly attended to which part so much 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 coal 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 central building over the office and waiting-rooms is an exception, being carried up so that the first-floor is the residence of the superintendent officer.

The cost of this building, with all its fittings and machinery, will not exceed £3,000.

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 baths 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 6d. first-class to 2d. for a second-class warm bath. Taking the average at 2d., gives a return of 12f. 18s. 4d., which, with the small amount from the wash-house, would raise the average weekly returns to 12f.

The expenses would be as follows:—

<table>
<thead>
<tr>
<th>Wages of staff</th>
<th>Per annum</th>
<th>Per week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superintendent and master, being also money-taker</td>
<td>£ 6 0</td>
<td>£ 0 0 0</td>
</tr>
<tr>
<td>Cook</td>
<td>5 0 0</td>
<td>0 0 0</td>
</tr>
<tr>
<td>Boy</td>
<td>1 1 0</td>
<td>0 0 0</td>
</tr>
<tr>
<td>First male attendant</td>
<td>4 1 0</td>
<td>0 0 0</td>
</tr>
<tr>
<td>First female attendant</td>
<td>5 0 0</td>
<td>0 0 0</td>
</tr>
<tr>
<td>Total wages</td>
<td>8 4 0</td>
<td>2 0 0</td>
</tr>
<tr>
<td>Cost of linen in summer</td>
<td>10 0 0</td>
<td>0 0 0</td>
</tr>
<tr>
<td>Total cost per week</td>
<td>19 3 0</td>
<td>3 1 8 0</td>
</tr>
</tbody>
</table>

Which, being deducted from the returns, would give an excess of receipts over expenditure of £1,200 a year, something like 10 per cent. We have much pleasure in being able to offer the above calculations, as they are the result of actual 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 rate-payers. 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 suitable 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 impliciting the daily consumption of coal and water, so as to ensure the machinery for the economical use of both—then these masters 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.

This 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, in our report of the 7th of August 1843, 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 the..." 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 too scantily lighted, but we conceived, that, as the painting 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 are 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 to the local conditions of 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 26th 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 a statue of each of such personages.

With regard to the Prince's Chamber, which we propose to decorate with statues, base-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 base-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 one of base-reliefs, to be subsequendy 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. 86, 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."
ON THE EMPLOYMENT OF A SOLUTION OF STARCH IN FRESCO PAINTING.

By W. Dycx, R.A.

TO SIR G. L. EASTLAKE, P.R.A., SECRETARY FINE ARTS COMMISSION.

In some observations on fresco addressed by me to the Commissioners on October 26, 1848, 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 adhesion to the intonaco might probably be reckoned upon with certainty. This was a more and more as a basis 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 fewer difficulties of execution; I accordingly tried it first, and with so successful a result that I have thought it useless to attempt the employment of casseine; but I may mention that since my suggestion respecting it was made, a Scottish gentleman has discovered and obtained a patent for a process of calico printing by means of starch removed from caseine, 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 his solution will be necessary to prevent 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 principally because I have been assured that 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 cruel enemy of fresco painters, is, when the pigment is combined with a weak solution of starch, of no difficulty whatever. It may be applied with tolerable certainty 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 pigment to dry in streaks or blotches. If the tint, therefore, is 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 were 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 be correctly, 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 trilling loss of depth occasioned by the admixture of white may be easily corrected by the addition of black, which, though it imparts a certain grey- ness 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 scanned over as a pure state, I may, if I mix 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, the mixture is to be crystallised or loosened, and 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 adhesion 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 adhesion of the colour under circumstances in which little or no chemical action can take place. As for day to day, at the end of a day the vehicle becomes quite hard on the surface, I have found small squares 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 Queen's Robing Room which have been painted in the same 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. 4

The Oaks, Norwood, November 21, 1853.

W. Dycx.

* Accompanying the above paper in the Commissioners' Report is another, bearing upon the same subject, "On Ultra, and Some of its Applications to the Arts," by Rev. J. Bache, M.A. This paper will be found at p. 383 of our present Number.
OPENING OF ST. GEORGES-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 cannot but be pleased with the fact that both Mr. Cockrell and Mr. Elmes, who have so long been known as advocates of the fine arts, were present. The building itself is a magnificent example of the style of architecture which Mr. Elmes himself has so admirably described and advocated. The design is bold and original, the proportions are beautiful, and the execution is perfect. The building is of red sandstone, and is surmounted by a large dome, which is supported by four columns. The entrance is through a portico of four columns, and the interior is lighted by large windows. The hall is large and imposing, and is furnished with handsome chairs and tables.

Mr. Elmes, in his official capacity, gave an excellent account of the building, and Mr. Cockrell, in his private capacity, spoke highly of the work. The occasion was a great one, and the building was crowded with people. The speeches were delivered in a most appropriate manner, and the audience listened with rapt attention.

Mr. Elmes, in conclusion, said that the building was a noble one, and would be a source of pride to the city of Liverpool. He congratulated the committee of the St. George's Hall Society on the success of their undertaking, and wished them every success in the future.

THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL.
In the other part's windows are freely introduced wherever they are admitted; 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 scheme will gain by the liberal introduction of sculpture: his suggestions will be found at the end of the 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 censured to the public; it is the subject of the schoolmaster, from whom the public, not to say the House of Commons, are long since used to receiving instruction. Is, then, the pleasure of many to bend to a few? And is the revival of the arts to be still farther delayed by continually disgustng 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 basalt reliefs, in which English people generally can feel interested, and comprehend without the aid of an interpreter. Mr. Cockereill's taste is so scholarly and classical that he is apt to lose the distance that separates him from the general public, and, perhaps, rather to contemn the feeling that would cater to their uncritical 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 amusement which has so well qualified to give. It is not likely that commercial men will feel complacency from the exhibition 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 Roman poet, when asked of his authoritative axe, seems likely to remind the profane vulgar of a chimney-sweeper's machine, and to excite amusement rather than respect. Even cultivated Englishmen, unless ultra-scholars, may rebel against the monogram "S.P.Q.R.," insomuch as they may think modern Liverpool, though not an empire city, is in many respects superior to ancient Rome. This is a gallery on the level 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 this gallery 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." This 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 basalt reliefs after the Elgin marbles. From this vestibule are two staircases giving access to the small court-room, which is small in comparison with the great hall, but is calculated to accommodate an audience of 1900 or 1500 persons. This room is over the vestibule and of the same shape, the orchestra being placed on the right side. The room is to be fitted up with seats on the floor and in boxes, etc., to be fixed.

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 bar, etc., has been opened, a retiring-room for the vice-chancellor of the Duchy of Lancaster, 99 ft. 6 in. by 23 ft., with a retiring-room; a robing-room for barristers; the library, 41 ft. by 33 ft., a second robing-room for barristers; the sheriff's court, 99 ft. 6 in. by 23 ft., with retiring-room; a retiring-room for the jury, crown-office for the clerk 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 after entering the eastern corridor, we find the east entrance door of the building being similar 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 court and hall are of course entered from the forecourt, 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 a large room, off which is a waiting-room for witnesses in attendance upon the grand jury, and then, proceeding along the eastern 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 gasoliers, and four rooms for the housekeepers. The changes of department, including butler's pantry, laundress, 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 accessible in case of fire.

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, armour-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 water closet, and a water gun. That which is attached to each cell requires 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 arrangement 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, furnaces and steam-engines, occupy a great part of the basement, where there is also another steam-engine to blow the organ.
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 arcaded columns of polished porphyry from Pentraeth, 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 two boxes by massive piers built behind each column to form the principal vaults of the first floor. The alternate arches are of 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 lightness to the design, and concentrating the thrust of the roof in two or three massive arches. Both the main vault and lateral arches are semi-circular 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 one side under the quadrangle, similar to those between the columns of the entrance hall. 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 Lancashire, 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 acanthus and egg-and-dart. The effect of the effect of the arches 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 pews 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 the principal column, but the entablature and 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.R," ("Senatus Populus Que Liverpoolensis") 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 rustrations.

Between the piers built behind the columns is a balustrade in front of the gallery, which is constructed of square dies of green marble, in which are seven small niches. Three in the middle enable them to be covered with gilt drapes and 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 figures erected in the attitude of grief are of well-knit faces, and covered with rich 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 that of the statue's 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 forms one of the most ambitious vaulted halls 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 6 feet 6 inches in width, and there are two semicircular windows at the ends, 30 feet wide. It is complete in structure, 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. Helena. 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, Rococo, Canning, Hesketh, and other distinguished men connected with the firm. What will be done is not yet determined; but temporary gazing 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 filled with the arms of Liverpool, with columns, three for 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 work has been done on the south, the two porphyry columns 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 of St. George's Hall. 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 relief, 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 glaze (usually red) a deeper and richer colour, and gave the white ornament a yellowish hue. These tiles were often arranged in sets of 4, 6, 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. Similar examples may be seen in the churches of St. Denis and St. Omer, in France, and specimens from the abbeys of Juvavum, Westminster, and other buildings in England. The modern process of encaustic tile making, as adopted by Messrs. Minton, Hollins, and Co., is to make masters not only as for Derwentwater tiles, but with great 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 75 feet, and 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 semi-circle, 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 of laurel, and mounted on a star of 16 points, the space 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 stones, and then follow rich bands of classical ornament, and a frieze of life-bearing ornament, composed of tritons, seynymphs, dolphins, genii, tritons, 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 curved lines 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 intersecting rings, with the 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 ornament, almost as large as a man, 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.H.E. 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 mottoes in Latin and English, relative to those victors at the games 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 opusde, leading to the entrance to the court, are relative to justice and government.

On entering the hall by the north entrance, and descending the steps, we read on the right hand—

"A king shall rule in righteousness, and princes shall rule in judgment."

And

"LIBERTATIES HONOS ET SAPIENTIA JURIS DECURS." Proceeding onwards, opposite the figures of Prudence, we read—

"Nihil aetas abest a siti Prudentia."

1. Wisdom, dwell with Prudence.

Next opposite the figure of Fortitude is placed—

"Tu ex cento milia sed centa audacter lo."

2. In the Lord I have righteousness and strength.

Then underneath the figure of Science we have—

"Pauca sunt rei verum cognosce causa." The fear of the Lord is the beginning of knowledge.

Next comes Art, beneath which is inscribed—

"Arum intellectum qua scumi profita."

3. He hath given me skill that he might be honoured.

Then Justice, opposite which we have—

"Justitutum mentem et corum divin." By the kings reign and princes decree justice.

Next Temperance, when we have—

"Ne quaad nisi."

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." The motto 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 facit ostium." It is said that the cost of the floor is 6000L, 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 municipality, and ascribing the economy to the able management 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 8 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 oval, running all round. The doors are hung to the frames with strong gun-metal hinges and ornamental bolts. One of the pair of doors has 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 interspersed between. The figures which is a small band with the monogram "S.P.Q.R." 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 rock bolt secured and locked by a key. The iron gates weigh 42 cwt.

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 river, 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 48 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 31 feet long and 15 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 western end. The cost of these doors is about 600L. They were made by Mr. Potter, of South Moulton-street, London, from the design and under the superintendence of Mr. Cockrell.

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 itself about 9 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 a ton. Yet, massive as they are, they look light, graceful, and elegant—a result due to the beauty 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. It is decorated, with a central core 30 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 uphold a large crown, and the upper row a smaller coronet beneath, from which again hangs an oblong shape in a low bow, to which is fixed 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 acaenaus 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 coronae below. The larger corona, fixed in the niche is supported 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 fitting itself of those from the same point. On the lower and smaller corn, 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 acaenaus leaves, below which are a series of tasteful mouldings, ending in the final gilt plate on the wall, and there are 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 other works, to be given. The work of the two ships 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 spaces being 300 ft. 300 ft. It is meant 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 3000£ and 5000£. 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 size of the case, all of the work, 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, 4 4 G to A in allumino, 60 notes; and two octaves and half of pedals, F to G, 4 C to F, 30 notes. There are 108 stops, and 8000 pipes, varying in length from 33 ft. to 15 in, 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. 6 in., while the smallest is less than 1 in. 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 coloating 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 distinctively or separately to the manual stopes. 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 organ, by one operation. One 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 of the performer's thumbs. The pneumatic lever is also applied to the opening and shutting of the swell lourves 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, with the exception of the 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, 60 ft. by 47 feet, with a recess or niche, windows, and a portal, large principal head, and also a pendant, descending from the prow 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 fitting itself of those from the same point. On the lower and smaller corn, 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 acaenaus leaves, below which are a series of tasteful mouldings, ending in the final gilt plate on the wall, and there are 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 other works, to be given. The work of the two ships 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.

Nikis Prais Court.

At the north end of the hall is the civil court, which is also rectangular, 40 feet by 26 feet, 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 coro.

nice rises the vault over the centre of the court, which is semi-circular 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 altar or apartment, or small chapel, is covered by a semicircle, not flat, but coffered. The niche for the bench resembles that in the crown court in being square on plan and finished with a semicircle, 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.

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 nation will always rejoice that 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 Beurling occupied the chair.

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 in the hall. 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 subervent 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 times 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 pointed buttresses and a predomiance of pinnacles, 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 incoherent and intersecting objects. What may or may not be the 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 innocuous.

But this is not all. Than the edifice in question there is perhaps a building, except that of the temple itself, that is more dependant on its columns and pilasters for its aesthetic qualities; indeed, the exterior may be said to be made up of columns, and its most striking beauty to consist of the grace of perspectival perspective. For the embellishment of its fore-court, 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 a matter of infinite concern; for such a pleasing effect is inevitably detracted from the delicacy and beauty of the façades, and thus impoverished what they were designed to enrich, and diminish results they ought to heighten.

It will perhaps be answered, that erections similarly proportioned, and similar in style, to 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 propyleum, 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 unmistakable 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.

It is not only the effect 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 lines, 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 figures grouped? Whether or not, such embellishments of that portico is requisite, if the balustrade be taken from another standpoint, and give it dus decoration as the grand entrance, a distinction to which its superior breadth and columnar dignity, as well as its central position, unmistakably points.

I hinted above at the impropriety of using the columnar form for, or substituting for, the structure of a good building. 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 level of balustrade, the piers to the character of pilasters, and the ordination 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.

I am only saying the marks of which I have but slight hope of their effecting in any degree the remedy of the complained-of evil; 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 HUGOFS.

Liverpool, August 21, 1854.

Sin—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 point of beauty and character of form. And further, the conception has been fully developed by phantastic sculpture; for the absence of which no array of elegant balustrade, or elaborate pilasters, or granite lamp-posts, will atone. Statues over the broad colonnade of the central portico, disposed as should be found in the finest and most beautiful temples of antiquity, while they would find an excellent background in the vast wall of the reeding 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 transmutation of life and beauty through the whole, awakening it, as it were, to a new existence, and making it to a higher and purer region of art.

It was for such adornment and vivification of architecture that statutory and figure sculpture had birth in ancient art. In Greece, whence the elemental origin of St. George's Hall, as well as in medieval 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, just as 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 statutory 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, to be associated with it; and almost additional, and 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 reduced by the employment of stone, the price of which is not at present exorbitant; by the employment of small and unassisting 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
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 our textbooks, and yet it contains more 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, 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 1833, 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 the subject in 1834 and publishing on it in 1835, to the engine, 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 these divisions are especially 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 his labours.

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. To the state of chemical science, 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 of 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 gaseous 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. Poclet, 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 combustion 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 in 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 contovers 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 engraving), or the Argand principle. Mr. Williams very pitifully observes, that it is too readily taken for granted that air by any means be introduced into the fuel in the furnace, it will as a
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 fumes,—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 refractory 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 combina-
tion with its high temperature. These are distinctly perceptible from the right holes at H.

The same result 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.

In the case 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

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 the second case, 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 fumes 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 effect 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 Argoand burners,—the gas is admitted the same way in all three—the difference to be noted is, 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.
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, 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 thus 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, nothing is to be compared with the three experiments corresponds with what takes place in furnaces and their fires, 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 Treverny, 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 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 8 inches above the feed, 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 eight holes at the end of the boiler 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 dome 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 heretofore will be shown.

In the course of some investigations on the principles laid down by Sir Humphry 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 live boiler from the back end, a body of flame will be seen flashing along from the bridges, 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 locomotive 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. 13. The distance, then, to which flame will penetrate tubes, before being extinguished, will depend on the rapidity of the current — the size of the orifice — and the quantity and character of the gaseous products, entering in company and contact with it. These products are, from

<table>
<thead>
<tr>
<th>Coke</th>
<th>Carbonic Acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>and Nitrogen</td>
<td>Carbonic Acid</td>
</tr>
<tr>
<td>Gas ...</td>
<td>Nitrogen, and Steam</td>
</tr>
</tbody>
</table>

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 the 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 agent; and in proportion to the heat required to carry on combustion, so if 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, those 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 gaseous 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 3 or 3 inches, it will not be sufficient merely to provide tubes of 2 or 3
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 2.4 or 2 inches, and so in proportion to the size of the tube, and the amount of pressure exerted by the current. So little, however, has this been considered, that not infrequently 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 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 prevent of that combustion. This results from bituminous coal containing from 6 to 8 per cent. of hydrogen.

The smoke question is only incidentally and collateral 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 we are 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. Poolek, 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. Poolek 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 be mentioned, as being of frequent occurrence, namely, a deficient draught in the side or upper furnaces of boilers.

M. Poolek 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 instance, 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.'

"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 velocity than the other, the latter is pushed back, and the influent falls up to its source. The result of this collision in the flue may be avoided by the diaphragms D (fig. 15). Such conflicting currents may be found in almost all marine boilers, yet pass unnoticed, even where the draught is most readily deficient in consequence.

Again, phenomena of the same kind will be produced where the currents of two flues are at right angles to each other, as in fig. 16. These effects may also be avoided by the diaphragms 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.

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. 19. The circumference 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.

In these boilers, attention was given, almost exclusively, to two objects:—providing the largest possible amount of fire grate area, 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.

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 cause adopted 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 furnace by a single opening, which is not only at right angles with the flue from the four centre boilers, but directly opposite to those of the wing boilers on the other side. Thus the flue 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 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 18 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 flues to the furnace, and, by firing the two furnaces alternately, the supply of gas is equalised on entering the flue from the bridge.

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. 26 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, inasmuch 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 flue, 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 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 than the other.

That the relative direction of the wind, and the vessel's exercise 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 central flue, passing to the reverse 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 showing working of Patent with Tackle at Fig. 6 & 7.

Fig. 5.
Horizontal Section through Trigger.

Enlarged Sketch of Tackle.
Pitched Iron Chain wound with Fags on woodwoose barrel to lift and detach the Ram by means of bent Iron. Spring and Gatch acted on by trigger as above.
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 manner of driving its parts; i.e., the driving jaw is 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 weighty, trigger device, which, when the 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 the ram.

They should be equidistant, and always extend 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 it with apparatus consisting of 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. 3 is a side elevation; fig. 4 is a horizontal section (on an enlarged scale) in the dotted line of figs. 2. A, A, are standards or guides for the ram in its ascent and descent; 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, (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 spring G, by which means the jaws g, g, and J, are kept closed against the arms F. In use, the arms F or G may consist of a band of vulcanised india-rubber, or a metallic spring or spiral of 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 fig. 5) forces the shears over 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 of such stops, as at fig. 7. T, is a chain of the form of 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 M, is a pulley at the lower part of the standards A, A, under which the tackle V passes. The carriage H is mounted in a carriage M, which is capable 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 increase 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.

If the pulley I, is omitted, 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 to the same measure 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. 3), which is thereby secured at any required height at the back of the standards A, A. The carriage Q is connected 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, and cause the jaws to open suddenly, by which the stop at once looses 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 ram against the cone, and the arm pressure on the inside of the jaws G, again closes 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, and they may be adapted to serve for driving piles of an endless tackle with stops and suitable pulleys;
This division includes a main sewer from the Bulletin Loan to the Coldstream-road, thence to the Coal-market, up the Woodmarket, and through the south and west sides of the market-place to near the Flesh-market in Rochdale 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 tributary sewers form a system of pipes, the cross-section of which is oval—being somewhat egg-shaped—the main 3 ft. 9 in. by 3 ft. 6 in.; the branches 3 ft. 4 in. by 3 ft. 3 in. The invert of each pipe is of a flat brickwork set in cement, the sides and top arch to be of rubble. This form is preferred to secure an equal and rapid flow, and the combination of materials is recommended for economy, both in cost and use of materials. 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 13 feet); but the uniform and rapid flow which will be obtained, will effectually prevent silt 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-skew-pipes, varying from 9 to 15 inches in 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 intersecting ridge already referred to. The heavy expense which would be involved in the tunnelling of the ridge, has prevented Mr. Brunles 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 insufficient, 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 embraces about 1354 yards of earthenware pipe, from 6 to 15 inches in diameter. (3) The third, or mill division, 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 16 inch earthenware pipes. The main and tributary sewers are laid in straight lines, as far as practicable, 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 conditions of the rainfall are remarkably favourable, varying from 1 in 200, 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. Brunles 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 chemists, and the expressions of important illustrious 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 2s. 6d. per annum, he estimates the net profit at nearly 5000 per annum, and this is exclusive of the liquid fuel produced. He proposes to construct these tanks of 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, urges the use of the sewage as a dressing, and hopes to employ 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. Brunles proposes to drain in the attached water-courses, without interfering with the uniform course of the working outlet, or capestan, 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 amount of the water, 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 Brunles, C.E., Manchester.

In compliance with a resolution passed by the chief magistrates and commissioners of police, of the "Burgh" of Kelso, Mr. Brunles 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 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 uses to which the highest buildings might be applied. 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 confines of the rivers Tweed and Teviot. The water-course is from 400 to 600 feet wide, and contains a large body of water, passing at a moderately rapid rate. The population of the town is about 3000. Kelso has a picturesque appearance, but is a very irregularly built town, and extends over considerable water spaces, being divided into two or more directions than the population might seem to indicate. The greatest 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 chalky hill) running in a transverse direction from the Tweed, and obliterating 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 any thing deserving the name of a system of drainage, and the authority for this condemnation has been fully arrived at, by 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 3 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 miasmate, which pollute the atmosphere; and the great mass of the refuse, carried beyond the sewage to percolate, and actually oozes 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 heavy rainfalls. 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. (2.) The second division embraces the suburbs as far as the limits permitted, into this division. The discharge for this main portion will be at the Bulletin 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.
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.

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 Broomblands plantation, and the high grounds to the northward; and 3rd, by gravitation from the River Eden at the height of 86 feet above Lowestoft. In the latter case, on 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 30 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 376L, and of the waterworks 347L.

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, 888 miles were in England, 86 miles in Scotland, and 77 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 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 12,658 miles. Of this number of miles 7868 have been opened for traffic, leaving 4800 miles to be completed; but the compulsory powers of 2838 miles have expired without being exercised, or of 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 3056 miles. The length of railway opened in 1843 was 2504 miles; in 1844, 2062 miles; in 1845, 856 miles; in 1846, 606 miles; in 1847, 803 miles; in 1848, 1188 miles; in 1849, 986 miles; in 1850, 682 miles; in 1851, 369 miles; in 1852, 446 miles; in 1853, 350 miles; making the total length then opened 7966 miles; of which 6545 miles are in England, 908 in Scotland, and 583 in Ireland. The length of the gauge of narrow gauge railways, including the Irish gauge of 4½ feet, 66 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, 2546 miles, of broad gauge 113 miles, and of mixed gauge 62 miles. The number of single miles of line in England, 139 miles in Scotland, and 441 miles in Ireland.

The total length of new line which was opened during the year 1853 amounted to 300 miles.

Of the lines opened in England, the principal ones are—the Oxford, Worcester, and Wolverhampton Railway from Wolvercote to Evesham, by which the manufacturing districts near Birmingham and the town of Worcester, and the industrial 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 York railways. By this means 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 lines open at the end of 1853, viz., 1708æ, 221æ, 14æ, viz., 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 1486 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 as far as the next station.

The amount of capital invested in railways at the end of 1853 was 284,189,800L, of which 161,400,266L consisted of ordinary capital, 65,700,764L of preference capital, and 66,488,685L of loan capital. The amount of capital raised in 1853 was 62,634,800L, of which in 1849, was 28,574,706L; in 1850, 10,532,867L; in 1851, 7,970,151L; and in 1852, 16,398,992L; thus increasing the amount invested in railways at the end of 1849 from 230,747,778L, to 284,189,800L at the end of 1853. The amount of money which had been raised by railway companies in 1853 was 60,409L; the number of men employed on railways open for traffic was 33,357, and 107 per mile in 1853.

The number of passengers conveyed on railways in the United Kingdom in 1853 was 36,758,051, an increase of 405,905, or 1.14, above the number in 1852. The number of passengers in 1853 had been 36,352,795. The total receipts from all sources of traffic amounted in 1853 to 16,035,678L, and in 1852 to 16,710,554L.

The receipts from goods have increased from 4,750,804L in 1848, to 9,512,471L in 1853, being an increase of from 1094L per mile in 1848 to 1410L in 1853; whilst the receipts from passengers in 1848 were larger than the receipts from goods in the proportion of 53:43 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 7,922,239, and in 1853 to 10,099,254, which represents 9693 per mile in 1849 and 9644 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, 2863 second-class passengers per mile, and 6907 third-class passengers per mile, against 1107 first-class, 1971 second-class, 8185 third-class passengers per mile in 1853. The receipts from passengers having increased from 540,778,865 to 597,719; or from 6804 per mile in 1849 to 7193 per mile in 1853; and the receipts from each class conveyed are shown in the same table. Against 1849, 1492 per mile for first-class, 1064 per mile for second-class, and 3311 per mile from third-class passengers, against 1811 per mile from first-class, 1796 per mile from second-class, and 3452 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 630,640s., and in 1853 it was 1,068,016s., representing 816s. per mile in 1849, against 1075s. per mile in 1853. The relative proportions of the two descriptions of traffic were, in 1849, passenger traffic 4538, and goods traffic 5425; and in 1853 the receipts from goods traffic amounted to 8043 per cent. of the whole traffic.

The amount of Railway traffic in Scotland 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 6659,947, or 14,142 per mile; and in 1853 it amounted to 7074,475, or 1975 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 1853, 217 persons were killed, and 456 injured in the railways on the United Kingdom out of a gross total of 581,373 passengers; of these persons 181 were killed and 413 were injured in England; 54 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 102,286,600 passengers conveyed by the railways of the United Kingdom, 935 were killed and 449 injured; of these, 243 were killed and 369 injured in England; 37 were killed and 89 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, for Means for their Improvement, the existing Legal Powers for the Purpose, and the Necessity for further Legislation thereon.

Patrick Besset, 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 bounded 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 river and the district of Woolwich to the northward 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 and a half to a mile and a half.

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 of the river; the second is the rise of the water in the river, and the increase in the number of persons in 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 38,000. 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 the marshes, and the banks being covered with grass and reeds. The scheme which would drain the marshes would shorten the period when the malaria is increasing, and prevent the deposit of decaying vegetation. It is uncertain what effect drainage would have on 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 water, the north 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 under the chalk. The Woolwich marshes are flooded by the upland water coming down. The leakage through one bank in the banks offer an impediment to the running away of the water which comes down from above; it keeps the lands in a wet condition, and so obliges the water to flow over the surface or into the ditches. It is 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 it has been known to be wet all the time; this is the ordinary condition of the marshes. The marshes exercise 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. The marshes under water for a long period; there is a great prevalence of ague and intermittent fever. Some horses had been affected with the stingers, 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. Has seen that a rise in the level of the river, increased the number of rats 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 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; the water is hot, 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 likened river; said only if dammed up to the top that it may make a fence. The lowering the water in the marshes by a drain 3 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 the drinking places. The field that was called the greatest drain 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 Aclworth, 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 a higher ground, where he is perfectly healthy. William Dickson, Farmer and Land Agent at East Wycham, near Welling, Kent.—Holds sixty to forty acres of marsh land, part under the plough, part under grass. The water is pumped up too high sometimes; even now the water is going back in the furrows on the grass land. There is no possible drainage upon this part of the farm. 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 cwts. There is a deterioration of 14. and even 2%. 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 is not one of the ditches would work, even upon his own farm, not to mention any; there is no outfall. The tidal stream, which from receding carried with it the deposit. The marshes do not want lime as a manure; there is lime in the water, from washing the chalk cliffs about Gravesend, which is carried up by the tide, and mixed with the London sewerage that flows off into the marshes; the tidal stream, and the deposit. 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 lands, and the expense generally. 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, is 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 it would be necessary to remove the banks 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 to inflammation it goes on to produce water in the chest. When it gets upon the man, it gets upon the man, and he is cured of it. No doubt the malaria is debilitating to their constitutions, and the patients are debilitated by damp, by debility and water; there is nothing peculiar in these marshes to any others which he has seen.
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 the rain begins the turned-out horses have not a bad time of it."

J. Kiver, Surger 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 Wallscott district of that parish having been assigned to him, with some others, to overlook. He states in his 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 draining of the private ditches. For the most part, these private ditches are very imperfectly looked after. In the river bank there 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, on one part, the eastward side being in the occupation of the proprietors of Beroberths, 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. Two houses have, indeed, been built, a small 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 heartstones, 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 seeping 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. He is informed, that under the direction of the surveyor of Bouverie'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 inconvenient, and communicating with them are small pipe-drains for the houses, sewages, and cesspools, and also a small 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 Colling Faroilet, Bart.—Resides at Belvidere, close to the Erith marshes. The neighbourhood of the marshes is in a continual state of agra, 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 thoroughness of that district and that of this area. The high levels near 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 29,000 acres of land. Upon the north-east there are the Thames marsh district of 35,000 acres of undrained land, which is an area almost in a horizontal frontage, with a march 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 outlet; but the great means which has rendered that district well drained is, that a certain number of people 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 town that district becomes watered 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 fever in the district.

James Russell, Farmer.—Had a large farm in the parish of Plumstead; at his own expense under-drained about 300 acres, and found a considerable benefit by it. Thinks all the land in the parish requires under-draining in the marshes. Finds his farm then has been much improved. Under-drains he has made for the marshes are 8 inches wide, and the sluices for running 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.

Richard Heath, Surgeon, Gravesend. Fevers and agues are the prevailing diseases in this 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.

David Coles, M.D., residing at Oatley, in Essex. The whole type of disease which prevails in his districts indicates a malariaous 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 pariah standing off the marshes and very high. In the north the marshes are flat, and the ground itself is better drained; it is not swampy.

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-walk to Gravesend bridge. The date of the commission is June 30th 1858, being a renewal of commissions which have existed 300 or 300 years. The first was established under 31 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 occupiers, 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 the county of Kent, and is paid into the hands of the justice of the peace having office for the county. It is paid 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 Indoor Commission; if the commissioners were empowered to do any new works, unless three-fourths or any stated number objected after notice which might be prescribed, that would probably fairly 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 expeditor; they then inspect the work which has been done during the previous year, and the expeditor 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 a place appointed in a hotel in the town, with 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 rents to be prepared; and then, at a subsequent meeting, the warrants are issued. The books are open for the inspection of all interested occupiers. They then levy what amount they please when the works are consented to. The great number of occupiers is the main difficulty to the consent 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 evils of London in certain seasons assumes, to use our language, quite a misanthropic 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 unconnected with it in any way. The surcharge that is conveyed, no doubt, a considerable distance; sufficiently authentic cases are recorded to show that the influence of marsh malaria 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 RAMELL, 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; and on the south side, is about 28,000 acres; and there are 8,000 acres more than 18,000 acres; being a total of nearly 36,000 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 1,000 acres. Then there is an open space extending from Blackwall down to Purfleet, where the high land touches the river: that I have calculated in three separate areas, of 9,000 acres, 2,000, and 3,000; making altogether about 7,000 acres in that area. There is then on the north side, an area between Purfleet and Grays containing nearly 1,000 acres. Then there is, between Grays and Tilbury, an area of about 3,000 acres. These areas have been roughly measured from the Ordnance map. Under the Metropolitan Commission are the Island of Dogs and part of Greenwich marsh, making together about 900 acres. There is then a commission extending over Dagenham, on the north side of the river, that area extending from Blackwall to Rainham, and contains about 5,000 acres. Then there is a commission with about 6,000 acres, on the north side, between Rainham and a point below East Tilbury, just opposite Hope Point. There is then a portion on the north side, near Fobbing, containing about 3,000 acres, and is under the same commission. Then there is Canvey Island, which appears to be under a separate commission; it contains about 4,000 acres. Then there seem to be about 3,000 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 3,000 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 the 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 ft. above the low water of neap tides. A neap tide on the 4th July last rose 14 ft. An ordinary spring tide rose 18 ft. 6 in. The Plumstead and Welling levels are subdivided among the different owners: Hence it was a double purpose of fences and of reservoirs for supplying water to the cattle. The total length of ditch upon the area is about 84 miles, which, at an average width of 6 feet for each ditch, will give about 60 acres of land. Fount the level of the water is from 7 ft. 6 in. to 9 ft. above the depth of subsoil drainage; should take 3 ft. 6 in. to 4 ft. as the depth of subsoil drainage.
are at levels respectively of 3 ft. 6 in., 3 feet, 9 ft. 8 in., and 2 feet above the level of deep tidal. The best corner of the seacoast 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 stream from the gross land getting into the arable land, by using the ditch as a fence, and planting along it, or along 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 6½ miles might be laid dry, and a hedge fence added to the sluices in the manner just described. 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 castle; thirdly, into works of fencing; and fourthly, works of subsoil drainage. The main works which he proposed would cost about 8000£; they would consist of a main cut through the center of the level, with other cuts leading to five outfall sluices, those sluices being placed at a level of 3 feet above low water. 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 every tide, he proposes to fix the sluices at 8 feet 6 inches, which would be included in the estimate of 8000£. 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 3000£. For the fencing he puts down at 8400£; proposes to have quick planted on one side of the ditch, protected for the time by a three-rail 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 16,000£ or 6.10s. an acre; proposes to do it from 2 ft. 6 in. to 4 feet deep. Considered the cost of pipe fence would be nothing; the trenches about eight yards apart. Has taken 1d. a yard for the laying, and 1d. a yard for the pipe; the whole of the works described would involve a total outlay of 38,000£ on those 3000 acres of land; or 12s. 4d. per acre. The outlet per acre on the main works will be 21. 1s. 2d.; on those for the supply of water, 1s. 6d.; the fences will cost 2. 16s., and subsoil drainage 5. 10s. 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 53. 1d. per acre annually; for the fences 3. 4d., for the subsoil drainage 6. 5d.; making a total of 14d. 5d. per acre annually. Imagines that the annual expense of keeping up this fencing, clearing the quick, and so on, would not exceed the annual expenses of keeping up the fences previously. Would balance the interest; 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. 4d. the annual expense of keeping up the fences; the 3. 4d. represents the annual instalment per acre for that item, spread over thirty years. Supposes the posts and rails would last about ten years, and be out of repair, 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 water itself is the only element that will 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 a level of 3 feet 6 inches or a foot; the quick will be sufficient to repair, and for that purpose the report of 1867 was made. The report of 1853 was more with regard to the drainage. After the works that he suggested in 1847 were carried out, in going over the marshes again in 1855, he found that ague had been very much less, from lowering the ditches and not having so much water in them. Thinks the expense of getting 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 mean water mark of each one and making the sluices lowered 3 feet (the bottom of the sluices is 4 feet above low water), the Great Broad 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 the fields and to the dwellings, and 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
Portion of Iron work.
¼ full size.

BOCKING CHURCH, ESSEX.
INNER DOOR IN SOUTH PORCH.

J. D. W. del.  
Publ. by D. Roeve, 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 parishes to throw down their ditches; it would not only save the expense of the improvement, but it would be entirely impossible that the water would be drained away. Mr. Rammell has advocated the 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 ditches, and the daily corn-yards that run them. The main outfalls run into the river, and by lowering those 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 same time, a thorough drainage and a thorough subsoiling must be 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 might be 60 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 in the water. 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 all the ditches arise from the full outfall 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 14.5d. 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 14.5d. 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 sect, it is about 50s.; the wall sect is from 7s. to 8s.; it is worth about two guineas an acre; the wall sect is deducted. The owners and occupiers are not favourable to a large outlay. In sinking the main ditches they are not willing to part with the property, has not made a 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 cut so as 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 1670l., including the sluices; then, for sinking the private ditches and preparing drinking places for the cattle, he estimated the cost at about 150l. Does not think it would do to choose the farmers generally from the farmers; in most districts you find but few farmers who would be intelligent enough for it; generally speaking, they think 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.

---

**Review**


(With an Engraving, Plate XXXV.)

During the progress of this work, through the kindness of the proprietors, we have hereof 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 doorways and windows, 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 suitability 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 encyclopaedic 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 Summerring, Austria.**

By Carl Genoa. Vienna: Gerold and Son. 1854.

This truly splendid work is the production of the director of the above-named railway, Carl Genoa, knight, who, in 1843, was dispatched to the United States for the purpose of studying the plans 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 Summerring 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.**


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 some matter, as dry peat powder, powdered green mould,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-
ON SILICA AND SOME OF ITS APPLICATIONS TO THE ARTS.  

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, may respectively be taken as examples of crystallized and uncrystallized silicas. 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 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 combinations more or less well known. But, when silica is mixed with an alkaline base only, silica forms a soluble glass, the degree of solubility of which depends on the proportion which the silicious acid bears to this alkaline base. This soluble silicate of alkali (or water-glass) may be prepared by various processes. One of the most usual is to mix fine sand, of which 8 parts of carbonate of soda, or with 10 of carbonate of potash and 1 of charcoal fused in a furnace, will produce a silicated alkali which is soluble in boiling water. This water-glass has been applied to several important purposes, and is of especial importance.

1. 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 districts, and cannot but corrode the calcareous and magnesian ingredients of calcrites 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 are interested in the formation 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 gluing of insoluble silica will be formed about the stone against the effects of moisture, &c. This cause of protection applies chiefly to sandstones. But whatever 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 projected to take place between these and the alkali of the water-glass. Kühnmann remarks "Tretes 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 pas complet."

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 calcite or dolomite building-stones.

This expectation, however, has not been altogether sanctioned by experiment. A gentleman, eminently conversant with building-materials, &c., who has been engaged in the study of silica of potatoes in the month of January 1840. 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 freely 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 a glass stone on the roof of a building, 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.

II. Another proposed use of the water-glass is that of hardening cement, mortars, &c., so as to render them impermeable by water.

Fourteen years since, Anthön of Prague proposed several applications of the water-glass in strengthening 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 water, and that a 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 silicate, or whenever it comes into contact with a lime-salt, has been applied by Fuchs to a most important purpose. The stereochrome is essentially the process of fresco secco invested with the capability of receiving and perpetuating works of the highest artistic character, and which may be executed on a vast scale. Fuchs's method depends on the use of a mixture of clean and washed quartz-sand 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
to remove the layer formed in contact with the atmosphere, the wall will be still moist during this operation. The wall has now only to be fixed, i.e., moistened with water-glass. 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 kept moist for at least 14 days 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 putty and to be fixed again. Being fixed in this manner, the wall is suited to dry. Before the painter begins he must first of all examine the part on which he has to work, and by brushing it with distilled water, squinted 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 carbuncles 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 admittance of being retained in its white state by distillation of its water joints), it appears that damp and atmospheric influences, notoriously destructive of real fresco, do not injure pictures executed by this process.

The following crucial experiment was made on one of these pictures, which had been fixed 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 and 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 of the dimensions of which are 21 feet in height and 244 feet in width, single colossal figures, friezes, arabesques, chiaroscuros 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 oblicite stones (such as Caen stone) is found to be protected by the process already described, it might be used, as a natural imitation, 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 allusion.

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 whole may be, or whatever the advantages of the competition are, yet I think it is 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.

ARCHITECTURE.

AUSTIN'S SUB-WAY.

It is here proposed to provide for all the desiderata required in our main London streets—for drainage, watercourse, gas, water, electricity, railage, &c., 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. Petro's establishment), the inventor, or projector, proposes to run his large drams 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 many, 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 tramways, 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 spandrels and crown of arch, filled in with concrete, receives the paving. An "eye" and arch is formed through the roads, to footways, fronting each house, for the services (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-holes and doors 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 soil gasses from Sewer.
B. Patent Water-Trap over Gully-hole.
C. House Sewage Pipe.
D. Low Level of Storage waters.
E. Flood level of Storm waters.
F. Outfall to River.
G. Supply Pipe.
H. Pipe to Flues for communicating foul Gasses from Sewers.

This scheme appears 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; 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?
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL.

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, running 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 Treth-Canal, which connects the Treth and Mersey Canal near the Harlescastle 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 be closed on Monday but for the rain, which has fallen since then, and the "cloudy, misty" weather which prevails in that district gives some hope that an entire suspension 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 districts traversed by these canals, there is no supply on which it is possible to canals, 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 Ramsbottom, is fortunately situated, for all the canals we have mentioned "lock down" 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 increased 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 upward of 800 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, newly opened ones, the immense reservoirs increasing the facilities of the whole district, and creating a demand for water, the supply which was never 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 mountains of the Derbyshire and Staffordshire by the Manchester and the neighbourhood, and also a large quantity of coal. In 1800, 11,000,000 tons of Manchester coal was sent up the canals to supply their coal, 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 coal in the United States for gas purposes is largely on the increase. On the seacoast 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 coalite 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 many cases 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 satisfactorily. The others are retorted, with the exception of details of manufacture in the establishment at Philadelphia.

These works are in the hands of the Municipal Corporation; capital invested 1,400,000 dollars, 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 the present time. 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. The present works are remarkable for the greater 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 ease, we intend to 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 168 ft. 8 in. diameter and 46 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" x 3" x 1/4"; Cup, No. 10 sheets and butts, 20 inches. Outer angle iron, 3" x 3" x 3/8"; Cup, 8 rows and 4 wide in the clear. 24 legs of cast-iron, each in five lengths. Top cup (angle iron), 4" x 4" x 3/8"; 3 rings of angle iron at equal distances, 23 1/2" x 2 1/2" x 3/8". 48 plates, riveted to the legs with hot rivets 4 x 1/4". Crown, straight rise of 4 feet to centre. Crown-plate, 4 feet diameter by 3/8-inch thick; 15 rows of sheets; crown-rows Nos. 8 and 10; rest Nos. 12, except the outer which is No. 10. King-post, No. 3, boiler iron 25 feet long and 30 inches diameter; top ring, 4 1/2 x 4 1/2 x 1/4"; bottom ring, 4 1/2 x 1 1/2"; two rings for nut at end of bolt, 4 x 1 1/2"; bottom plate 3/8-inch thick. All bolts and nuts for crown end of bars, 1/4". Crown to be on 7 rings of plate and angle iron. No. 1 plate, 3 1/2 x 1/2"; No. 2 angle, 3 1/2 x 1/4"; No. 3 plate, 3 1/2 x 1/4; No. 4 angle, 3 1/2 x 3 1/2 x 3/4; as to break joint, No. 5 plate, 4 x 1/4; No. 6 angle, 3 x 3 1/2 x 3/4; No. 7 plate, 4 x 1/4. All plate-rings secured at the joints with butt plates. 24 trusses of round and square bar iron, each truss having 7 struts. On 5th and 6th rings; 38 inches in diameter, and 48 square, or 1 inch square; on 4th (main strut), bars of 3 1/2", riveted at distances of 1 foot, and blocked apart with 3/8-inch washers; on 5th and 7th, double struts of 1 inch square bars; on 6th double struts of plate; each leg two bars of 2 1/2" x 1/4", similarly secured with No. 4 (see drawing) round iron tension rods of mission 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 45 stainless hexagonal braces with 4 1/2-inch bolts. Lower Section.—190 feet diameter, and 45 feet deep; sides, 30 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" x 3" x 3/8". 24 rollers and carriage on the cup between the sections. 24 rollers and carriage on the cup on guides. 30 hooks for suspension from the tracks. Aggregate make (1862), 220,000,000 feet; present price 92 per 1000 feet.
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 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 mast previously 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 dependences 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, more likely, he would have introduced for its protection the same expeditious 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 pulling a cord.

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 boatwain’s cabin about midnight, on the 26th January, 1853. This fire was discovered by the police. A servant 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 dock-yard, 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 acoustemising them to use the fire-extinguishing works for as many purposes as possible; for instance, for watering the decks for washing store-house windows and the fronts of buildings, &c.

Hampton, August 16th, 1854. M. S. BENTHAM.

AUSTIN’S PATENT HEXAGONAL SEPARATING DRAIN-PIPER.

The object of this invention is to afford ready access for clearance from any obstructions, and to prevent the present waste of breakage consequent upon the clearing of socketed pipes. These tubes are also available for casting 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 breaking.

On this form of construction (honeycomb) Mr. Austin has also patented caissons 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 Southwark-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 4259; the number of patents passed thereon, all having become due on the 30th June last, was 3396; 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 1197.

The number of applications recorded within the first three months of the operation of the Act, was 1511.

The number of applications recorded within the year 1853, was 10,545.

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 (1811) 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 185 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, 3096 in number, have been printed and published, together with lithographed outlines 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 letterpress, 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, 1858, to the present time, with copies of the titles 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.

Copies of all the patents registered since the passing of the enactment 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 original 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 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 propelled 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 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 copies of certified printed evidence copies at a low price, and the Commissioners obtain the drafts of drawings on 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 index of all the specifications of patents enrolled in Chancery, from 1617 to the 1st October, 1858, 14,339 in number, have been published in three imperial octavo volumes, and are sold at 50s., 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, may also 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. Copies of specifications have also been published in 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 published twofold in the Journal the names of patentees, and 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 50c. and 100c. 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 50c. 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 pretentious and more highly-decorated hall in which they were assembled last year. The number of members assembled was 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 Harewood) 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 illustrations, 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 them were not properly attended; and had it not been for 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 had, 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.
Secretaries.—James Oldham, Esq., C.E.; John Grantham, Esq., C.E.; James Thomson, Esq., C.E.

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 has 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 vessels requisite to preserve 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 blunt vessel 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 to do so. It was found that it was more easy to pull 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, at sixty 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 therefore expect to get twenty-four miles an hour until they had made up their minds to build ships something like 400 feet long. Not from all the experiments he had made, and had seen made, those facts were unchallenged; they would therefore perceive why such a large vessel as the Himalaya had such great speed. The Himalaya had a length of 330 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, 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 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 altogether stronger than the plates. There was proposed a distinguished man in that neighbourhood, Mr. Ashton Smith, and a very distinguished shipbuilder, Mr. Laird. Mr. Smith thought nothing of building ships of 190 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. 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. Granatham 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 they hoped that their discussions 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 respecting the possibility of the feat, he 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 coal, and having to stop for them and buy them at high rates at St. Vincent, the Cape of Good Hope, and sometimes the

Mauritus, created such an expense that no freight could cover; he showed how it became necessary to construct a vessel large enough to carry her own coal in 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 200 first-class, 400 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 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 8 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 standing 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. Dixon read a paper on the Prevention of Boiler Explosions. The plan he proposed was 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 G, 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 the chimney from lightning. The conductors consist of a fixed 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, that it 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 brickwork compared with the distance the lightning passes from the clouds to the earth, is insignificant.

VENETIAN SCREW PROPELLER.

Mr. Gratham 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. Gratham 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 Firth of Clyde docks, and it had also been applied experimentally to her Majesty's yacht the Faery, 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 overcrowding of such ships. The supply of air to the cabins is effected by two engines, each driven 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 sprayer, is inverted with the smaller end into the fluid; its upper end surrounds, and is perforated. This vessel rotated, and the fluid by the centrifugal force is drawn up and thrown out in spray, through which the air must pass into the cabins, thus becoming impregnated in its passage with the disinfecting material, such as the chloride of zinc or of lime. By placing a few boccalis 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 200L and 300L. The quantity of fuel required to keep the engine at work night and day is 100 to 130 tons of coal. 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 water-closets, 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 M.M. Malagutti and Dubrocher.

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 puzazzanas, which have set the most rapidly, are those which appear to best resist these causes of decomposition. Nevertheless, even amongst mortars and cements which are of 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 Pavers and Doné, and the mortars made from them, Boulgorgne, Portland, Pouilly, Vasse, and Parker's cements. We are indebted for them to the kindness of those skilful engineers of the Ponte et Chaussées, M.M. Jérubière, Watier, and Belleanger, 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 Pavers were immersed, under similar conditions, in sea-water during eighteen months.*

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 with the lime, and that the 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 considerable, 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 water-mark 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 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.

The explanation of these effects 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 Deuil, underlines the principle of the loss 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 two months; nevertheless, the 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, 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 mixture of lime and magnesia in a double cement, which tends to approach dolomite in composition. But there are cases where the lime disappears without the introduction of magnesia, and the phenomena appear 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 hydraulie, there is a division of the constituents of the mortar into two compounds, the one rich in earthy carbonates, the other rich in aluminas, coming to the surface and forming a smoky deposit, which the waves remove. This partition is not effected, or at least is not so evident, if the mortar is very siliceous, and is 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 mortar.

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 Poulilly, Vassy, and Parker have been looked upon as the best for this purpose. In the analysis of these three cements: it is, that they are very rich in oxides of silica, and 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 Poulilly 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 is capable of forming, in the humid way, combinations with lime. With this object in view, we formed directly kinds of puzolanas, by mixing mixtures of silicea 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 resistance; whilst the other assumed a flocculent aspect; it swelled out more and more, and rose to about 16 or 18 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 concrete 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 may conclude that the presence of this oxide would contribute to give to cements certain peculiarities which have never been imbibed 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 construction of hydraulic works, and further, because it is of the greatest importance that they 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 silicea, 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 build a brick vault or a mausoleum I do not know. The cramped size of the plots makes the whole affair, and building societies generally, look ridiculous.

Viator.

September 28, 1854.

Christ-Church, Newgate Street.

It has been pointed out to us that by the removal of the houses in Newgate Street, for the purpose of widening the road, 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 ornamentation, 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 as it now is, 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.

TH E 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 Donnay, 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 film plane could be converted into a curved one, and sometimes actually caused to close, so as to form a bell-like 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 umbrellashaped 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 form in the form of the liquid flask was observed. The latter became elongated, and 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 caused 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.

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. Newport.—New dwellings are 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. Chestnut.—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 that the capital of the northern counties is to have a new town-hall, music-hall, and public offices. Water-works.—Vestry Meeting of the 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.

* Paper read at the Royal Institution.

Counties Permanent Building Investment and Land Society.—The High Park estate, at Smithwick, 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 to consider the importance 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 districts in 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, and to be so constructed as to prevent 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. Bakker, Paris—Improvements in levers of ships and vessels

1137. L. R. Dufour, Paris—Improvements in breech-loading fire-arms

1139. R. Reeves, Bristol Westbury—Improvements in drills for drilling liquid marble

1140. H. Manegues, Rome—Improvements in the manufacture of boots, shoes, goloshes, or in shoe-making generally

1145. T. G. Cobbe, Dublin—Improvements in microscopes

1148. W. N. Nicholson, Newark—Improvements in hay-making machines, part of which improvements is applicable to carriage generally

1149. N. M. Cavalli, Glasgow—Improvements in the manufacture or production of ornamental fabrics

1150. J. H. Johnson, Lincoln's-in-fields—Improvements in the manufacture of carbonates of soda. (A communication)

1151. W. A. Gilber, South-west, Finsbury—Improvements in the application to wetting the tallow in certain paste and bituminous employed, either alone or in combination with silk, cotton, and other fibrous substances. (A communication)

1154. R. B. Marson, 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

1157. C. M. Archer, St. James's-gardens, Haverstock-hill.—Treating all kinds of paper wherein any printing, engraving, engraving, letter-writing, or lithography has been printed or impressed, so that the said printing, engraving, letter-writing, or lithography may be one of the acts of printing, engraving, letter-writing, or lithography which the said paper, and for the said paper may be readily read 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

1158. Sir J. B. Lello, Pall Mall—Improvements in fire arms

1159. R. W. Brown, Fleet-street—Improvements in treating raw silk fabrics while being dressed and dyed. (A communication from C. Jardine and A. Dural, Lyons)

1160. R. Roberts, Manchester—Improvements in machinery for puddling, drilling, and riveting

1161. A. Dottara, Paris.—The extraction of a substance for supplying the place of quinine

1162. H. Cosnard and J. B. Recluse, Diéges—Improvements in the manner of treasuring beetroot, and all other sugary and succulent vegetables

1163. R. Lavenu, Chancery—Improvement in the process of converting wood into paper. (A communication)

1164. W. L. Talbot, Aldgate—Improvements in fermentation and in apparatus employed therein

1166. P. V. Dalès, Paris—Improvements in printing-blocks

1166. G. Roux, Boulogne St. Martin.—Improved centrifugal governor

1164. R. H. Thompson, Old Chichester—Improvements in universal self-acting saving machine

NEW TOWN HALL AND COVERED MARKET, 
BRAFORD.

(With Engravings, Plates XXXVII. and XXXVIII.)

Two 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 Fairleigh 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-room, 50 feet by 30 feet; committee or ante room, 33 feet by 17 feet; and the three rooms forming the literary and mechanical institute—reading-room and library, each 12 ft. 6 in. by 13 ft. 6 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 clock and bell. The large light is 38 feet high, 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 stables, are eight sleeping-apartments for the police, and over the committee-room and in the 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 3000l., by Messrs. Long and Spinder, of Bradford; exclusive of old materials, which were valued at about 300l. more, stone, 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. Indiscretion of the funds subscribed for the usual expenditures at the seerées, 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 750l., of which the sum of 500l. was for the Kew Observatory, and 100l. for Strickland’s ornithological synonomy; 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 Argyll is appointed President.

ON THE MEANS OF REALISING THE ADVANTAGES OF THE AIR-ENGINE.

The author, Mr. W. J. Macquarie 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 to employ air as a working substance, it is evident 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 


1.88 lb.

2. For a double-acting steam-engine improved to the utmost probable extent 


2.90 lb.

3. For a properly constructed 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 1853—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:

<table>
<thead>
<tr>
<th>Engine</th>
<th>Actual Consumption</th>
<th>Theoretically perfect engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stirling’s engine</td>
<td>0.98 lb.</td>
<td>0.89 lb.</td>
</tr>
<tr>
<td>Ericsson’s engine</td>
<td>2.80 lb.</td>
<td>0.89 lb.</td>
</tr>
</tbody>
</table>

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 could 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 adopt it for general use. 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 theo-
ratically-perfect air-engine wasted two-thirds of its fuel, and Ericsson's somewhat more.

Other obtrusive 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 reduce the waste 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 realize 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 expanded. 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 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 instantaneous, and the gases could not be felt beyond the limits of the engine itself, and hot air does not solid.

---

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 himself, on the effect of pressure on melting points, and on the strength of materials. The apparatus by which the bodies operated on were subjected to pressure, and 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 to ascertain the exact laws which govern the cohesive strength of bodies in their natural physical conditions, and how far the knowledge of those laws may conduce to the reduction of the 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 under different pressures. The bar that was solidified under a pressure of 40,750 lb. carried 75 lb. per square inch more than one submitted to a pressure of 6,21 lb.; the ratio being in favour of the more strongly compressed bar, in its power of resistance to a tensile strain, as 1 to 0.702.

It appears from these experiments that the effect of pressure have not only their densities greatly increased, but 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, and tested under a pressure of 9,051 lb. The cube 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 901 lb. on the square inch. The same quantity taken from the same ingot was subsequently submitted to a pressure of 6,998 lb. on the square inch. The bars, which had been allowed to stand for upwards of fourteen hours, were subjected to the usual tests of tensile strain. 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 901 lb. and 6,998 lb. on the square inch, the break was respectively 4,653 lb. and 2,757 lb.; or in the ratio of 1 to 2,706, being an increase of nearly one-third on the crystallized metal when solidified under about six times the pressure.

From these facts it is evident that the power of bodies to resist a pressure greatly exceeds the power of the air-engine, for moreover 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 901 lb. on the square inch, had a specific gravity of 0.94808; whilst that solidified under a pressure of 6,998 lb., had its specific gravity increased to 0.94845. The specific gravity of tin solidified under a pressure of 6,998 lb. was 7.3053, and that solidified under a pressure of 901 lb. was 7.3154, which gave 0.0091 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 resisting powers of solidifying metal under 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 1/2 inches long by 1/8 inches diameter, after being hammered into the testing cylinder so as to be slightly consolidated, was reduced in bulk, with a pressure of 9,840 lb., to 2.95; with a pressure of 5,460 lb., to 2.93; with a pressure of 7,864 lb., to 2.298; and with a pressure of 9,588 lb., to 1.935 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 0.52 inches to 0.65 inches; About four inches of the tube, near the middle, has a capillary contraction, in order to produce an 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 pipe, or Gay-Lussac, 1.5 inches long, equal to 90,000 feet of air, 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 sheepekin leather firmly fixed by abutting flanges. The latter has been found sufficient to prevent 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 exceed that height. It is therefore 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 12 inches. The top of the tube is protected by a cylindrical brass cover, 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 0.0008 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 it would not be necessary to subtract the correction in making an observation. The connexion 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 into its stem, and having its lip 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 globulis from a point a little below the middle of the tube, the rack motion being close to the point of suspension, in order 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 jar, and is equivalent to the spring globuli usually employed, while much simpler in its construction.

**CYLINDRICAL LENSES.**

Professor Sturm, of Vienna, described a method of manufacturing lenses, which, by the improvement in accuracy of construction which 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 perfect cylinder is free from the defects of spherical aberration, and that the opposite rectangular planes of a cylindrical lens, 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, parabolas, ellipses, etc., 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 becomes more evident in the latter than the greatest 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 defects of spherical aberration; whilst two parallel spherical planes produce the effect of doubling the imperfection; consequently the former are much better adapted for this purpose.

The Abbé Moigno stated that cylindrical lenses were the invention of M. Chamblaud, 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.

**SUBMARINE TELEGRAPHIES.**

Several communications were read 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 the form of the instrument used for the telegraph, and the difficulties he 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 Plymouth and Corfu. 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 150 to 125 fathoms, it was about to enter a descent of precipices, 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 thebattery, and complete the experiment. The line was 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, and Egypt, in preference to the line by the Italian peninsula, which would ever be impeded by the feudal and restrictions of the people; 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 would be laid secure from derangement of any kind. He concluded with a statement of the labour and attention he had bestowed for many years on preparing the submarine cable of America, and of the depth, on the proposed line, as recently ascertained by Lient. Maury, of the United States, with some estimates of the weight and cost; and stated that a return of 1000. to 1500. 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-protected with the current, and that, if necessary, the wire would be greatly reduced, as it 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 coast of Ireland to the United States. The cost of 2000 miles of such wire, and to lay it at 300 miles, would be 75,000., and allowing 25,000. for the laying down and incidental expenses, a telegraphic communication might thus be formed between the old and the new world for 100,000. A single wire telegraph, he contended, would be sufficient for the transmission of news between England and America; for even if no quicker instrument was used than the needle, there might be 1000 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 gave his version of the 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 submersed wire, and he stated the means he had contrived for overcoming the same. The first public notice of the peculiar action of submersed 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, resembled in its effect a Leyden jar, the electric juice being coiled around 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 circumcised, a part of the charge is retained in the wire, and is not discharged until upwards of half an hour after contact has been broken. 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 proceeding signals are transmitted in the particular 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 intensity of the wire is not charged. Avoiding hints 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'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 needle. He also has a local battery to induce the mark of a 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 of the current 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 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 be capable of transmitting twenty-five words per minute, 3000 miles. To work the ordinary telegraph 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 donors' telegraphs, 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 and at short distances.

APPLICATIONS OF WATER-POWER.

Mr. Armstrong read a paper on various applications of hydraulic power, referring more particularly to the hydraulic cement dock-ket, and to a perfectly new and 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 crumage 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 impulsion to the extension of such machinery. The apparatus used for this purpose was called an "improved" application of Mr. Armstrong's invention, consisting 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 accumulation machines, various arrangements 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 was to work a large number 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 depicting events that take place in the atmosphere, called the "Gyroscope." This instrument was first exhibited and explained by M. Foucault, in France, to the Physical Section; it was afterwards shown at one of the soirees, when Dr. Tyndall explained its action in English; and it was subsequently exhibited to a number of members in 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 move accurately in the center 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 axis 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 axis and the pinion to appear on the outside, so that it could be laid hold of, or grasped firmly in the hand, if necessary. The second was carried in a box, with the mass inside was rapidly revolving without disturbing that motion. By this modification of the gyroscope, M. Foucault afforded a sensitive proof of the determination with which a revolving mass endeavours to maintain its own axis of permanent stable rotation; for upon this motion it was impossible to make the slightest, or 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 a kind of living being, with 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 axes, like the ring of the gyroscope. These axes could be placed in a small frame of wood bound 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 a gumbal, so exquisitely constructed, that both the gyroscope proper and the suspending gumbal, independently from each other, could be turned when placed in any position in relation to the earth. By this the author showed not strikingly the effect of any attempt to communicate revolving motion round any other axis to a mass already revolving, for, on placing the gumbal 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 gumbal, so as to bring its axis to coincide with the new axis endeavored 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 turning imparted to it. Having thus demonstrated the necessary effect of combining a rotary motion with another, M. Foucault then proceeded to demonstrate palpably that the earth's revolving motion affected the gyroscope in precisely a similar way. By various and ingenious adjustments, brought the gyroscope, in gumbals, 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 gumbal supports were placed on the gyroscope the same effect was produced as above; that is, as 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 earth. He concluded by saying that he was not sure that it was not by this experiment that it was sufficient to control the 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
wires projected, each in a hook; the wire coinciding with the prolongation of the axis of the gyroscopic, 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 steadily 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 swiftly, inverted. Next, in a manner sensible, he placed the gyroscope suspended freely by a fine silk thread 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 place 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 piece of brass at the end of the axis on the ring, the instrument went immediately through all the evolutions of a tap 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. The general 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 1529 lives, and 865 persons were rescued in various vessels in the southern coast of England, which is about 300 miles from the Land's End to the North Foreland, and there are but about 15 life-boat stations. The eastern and western coasts, however, are better provided, there being 40 for the former between the Land's End and Berwick-upon-Tweed, a distance of 448 miles, and 23 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 strong an established 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 forty years. According to the casualties compiled from Lloyd's list, and laid before parliament, there had happened 1266 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; 2885 cases of collision occurred, by which vessels were brought into port in a sinking state; 2282 were wrecked, 653 founded; 679 were abandoned by their crew; 97 were burnt by accident, and 81 damaged by ice. The casualties to steam-boats during the same period of four years were—103 driven ashore, but afterwards floated again; 148 founded; 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 falls chiefly on the smaller vessels of 90 to 600 tons, and which were economically sailed and badly commanded. As an approximate 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 1000, the greatest loss of 900 in a single year being 2488. The loss was computed upon the cargo of 198 tons, which the ship could have carried, and upon the average of 50 nearest cargoes of the same kind, and it was found that the estimated loss would be 187 tons. But this would not be the whole, the loss of the cargo must also be considered.

The Boilers of the Arctic.

Mr. Prosser read a paper on the 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, and consequently, its great source of error, and that, consequently, all other things being equal, that medium which requires the lowest 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 the vapor raised through the condenser was kept within the furnace of the boilers, and after being heated by coming into contact with it the steam was reunited with the other part which had not been so heated, and then passed into the steam-tubes and cylinder. The tubes of wrought iron, 4 inches in diameter externally, were about 100 feet long in early engines, 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 so simple, as it has been put in practice by Watt, and abandoned as useless. Numerous other and more complicated schemes of heating have been revived since various experiments have been made, but all of these by fallacious experiments to prove its advantages; but Mr. Prosser contended there is less, and no gain whatever, in heating the steam. He alluded particularly to the experiments and calculations which had led to the introduction 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 obtained from the "mixture", by heating the steam, and by adding "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 from it. High-pressure steam has 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 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, he 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 temperature which he calculated may amount to about 12 degrees. Considering this, he 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 to the heating of the steam. The steam has but about 3 the specific heat of water, it follows that the 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 position of the density of the steam being the same as water, there...
rate of absorption can be but 1⁄4, or equal to the specific heat of the steam, as compared with water, and requiring, therefore, the consumption of 1 ton of coal per day, that being all that the steam will take up. But the density of the steam, if taken only at 1800 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. Preston said he had endeavored 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 steam heating service to a boiler will be far more efficacious when applied in the ordinary way for the evaporation of the water in the boiler, 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 feverish motion of the water which is automatically bound to its 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 in a very large proportion of cases of condensation 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 are so rare as to, and far exceeding any other known medium of heating, not only increase the lightness of the steam, but, by forcing the emissions of the boiler, may be increased. Mr. Preston 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 steamers of a large working capacity, has a saving of about 30 per cent., more than that generally ascribed. Far greater economy will be attained, without increase of danger, than by any system of "charged steam" it is possible to devise.

RAILWAY BREAK.

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 six inches in diameter and three inches in the cylinder) and the area of the latter being 1904, less the piston rod, there would be an effective pressure of 1800 lb., to act upon the water. At the latter is driven upwards by the pressure, the piston-rod is elevated also, and, being connected with the levers of the hand-wheel, the hand-wheel is turned, and the brake is once brought into contact with the periphery of each wheel, and kept there as long as the cylinder remains in communication with the boiler.

VARIATION 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 Mr. R. Drury, in the Physical Section, and has explained the principle for which he has so far considered. 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-

Mr. Townson 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 might rest upon that progress; but they could only place them upon a satisfactory basis by gradually removing the objection of the effects of iron ships being brought into dispute by these means, it would not place them upon that foundation which would cause them to progress in Great Britain.

Several other gentlemen spoke on the subject, and it was decided...
THE CIVIL ENGINEER AND ARCHITECT’S JOURNAL.

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 meeting was 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 MONOBRAZEL 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
planks was the only limit, and for which the roller
should travel—in other words, the number of revolutions of the
trolley 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 30 feet diameter, and weighing
over 50 tons, about 40 tons of which is disposed in the rim,
which is intended to roll with a velocity of about 8000 feet per
minute, in making about 30 revolutions. Great care was neces-
sary, 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 scrutiny of Mr.
Fairbairn, who pronounced it as perfectly safe at a velocity of
16,000 feet per minute—number of revolutions, 130.

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 con-
struction of boiler-furnaces. He said that the prevention of smoke
was attainable 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 con-
sumption of fuel in ordinary furnaces, which is effected by the
constant use of the blowpipe, and by occasional checking of the
fuel with water. In Cornwall, where the engines are stimulated by rewards to make each pound of coal do its utmost duty, there would be no necessity for any further
considerations to be adopted; but in the absence of such stimula-
tion, it is desirable to construct the furnaces in such a manner as
to consume their smoke with ordinary management. The great
mass, he said, is to have sufficient capacity in the boiler; and if
boilers were made of double their usual capacity, the consump-
tion 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, b, c, d, e; are the bridges of the furnaces; c, d, are large tubes,
which conduct the products of combustion into a mixing-chamber
e, where the gases are mixed, and they then pass through the
boiler, 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. William’s furnace.

Dr. Arnold 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 inventing 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 ascending through the hot coals at the top, it is com-
pletely consumed, and converted into carbonic acid 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
core of a room without the risk of its smoking, and by this
arrangement a perfect ventilation is obtained than by any
other means.

Mr. Dickson explained Mr. William’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. Jekyl’s plan of
moveable bars was spoken of as the most effective for the pur-
pose of consuming fuel, though difficult to be introduced in furnaces
already erected.

THE SUPPORTING POWER OF PILES.

Professor Stewart made a communication on the limit of weight
which may be safely laid on a pile driven into the ground.
He said that the force which resists the penetration of a pile
may, under very particular 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
desired, setting the ram down at the same stroke as the previous
stroke, and carefully comparing the two distances it has been thus driven. If the resistance increases, then the actual
load the pile can bear will 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 prin-
ciples on which the calculation was founded: 1. When a moving
mass W, strikes another W, at rest, with the velocity w, then the
velocity, after impact, v = v 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 forces
are given. This way of using it, he then deduced the formula,
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; if the depth is
determined of a foot which 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:

\[ L = W \left( \frac{W}{W + W} \right) \left( \frac{h}{2} \right) \]

in which W, W, h and L, can all be had by actual weighing and
measurement.

RAILWAY SIGNALS FROM CHINA.

Captain J. Norton described some methods of establishing
communication between the guards 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
was propelled, the louder the noise; and Captain Norton said
the Chinese, by a way of using it, threw it down a flight of steps
and posted the stick into the barrel of a pistol charged with gunpowder, and
sent it over the engineer-driver’s head. In this manner he had
in 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 answer to the steam-whistle, indicating
that the engine-driver had heard it.
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL.

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 are half-ships, 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 by 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 chute where the end next the wheel falls beneath the bucket, striking a trigger that opens its bottom, leaving the contents free to fall into the schutes, and be conveyed by them into the transporting scoops alongside.

The machine, for some kinds of work, must supersede all others where the long stretch can be had, such as a bar of a river, the bottom of a canal, &c., the performance must with the most credit. No time is lost, except that spent in replacing the loaded scoops 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 this class, having a wheel 24 feet in diameter with four buckets, has dug 1800 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. Gresens, 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 and height, it might be 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 Fahrenheit, of the air within the flues; and those in the first column on the left, that of the air outside. The calculations are made according to the following commonly received formulas for the expansion, equilibrium, and flow of seriform bodies.

1. Gay Lussac's law showing their increase of volume to be \( \frac{1}{2} \) or \( \frac{3}{2} \) 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 \( V = \sqrt{2gh} \), and the coefficient of actual discharge is assumed as that for a thin plate, which well represents an ordinary damper or flue register, \( Q = 0.625 \sqrt{A} \), or fills 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 flue is computed; otherwise the computations must be based on its area instead of theirs.

The numbers in the table are here given for the sake of economy, and are not to be employed as a standard.

The small table appended below gives the proper factors to be applied as above, for flues less than 100 feet high:

<table>
<thead>
<tr>
<th>Height of Flue, Feet</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0.954</td>
</tr>
<tr>
<td>12</td>
<td>0.961</td>
</tr>
<tr>
<td>14</td>
<td>0.965</td>
</tr>
<tr>
<td>16</td>
<td>0.967</td>
</tr>
<tr>
<td>18</td>
<td>0.968</td>
</tr>
<tr>
<td>20</td>
<td>0.969</td>
</tr>
</tbody>
</table>

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 Missionary 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 3000L. Convenient teachers' residences are immediately adjoining.
TRINITY NATIONAL SCHOOLS, COVENTRY.—JAMES MURRAY, ESQ., ARCHITECT.
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 its southernmost point, through Ballylongford, two locks, and two fall locks. The distance to Castleisland, on Shannon, is a distance of 17 miles from the northern extremity of Lough Allen, the river divides into some places. A lock is a lock and weir in conjunction with the Boyle Weir. At Jamestown, Ballylongford, and Templebally, there are three locks, each 100 feet long and 40 feet wide, with compartments, which are effectively closed by the gates in the lock, adjoins the Shannon, is a fall of 30 feet, and its lower is the Athlone Lock. From Portumna to Killaloe, the river is broad, deep, and sluggish, requiring only one lock at Milwall, 30 miles above Killaloe. This lock has a fall of 60 feet, and its lower is the Athlone Lock. From Portumna to Killaloe, the river is broad, deep, and sluggish, requiring only one lock at Milwall, 30 miles above Killaloe. This lock has a fall of 60 feet, and its lower is the Athlone Lock. From Portumna to Killaloe, the river is broad, deep, and sluggish, requiring only one lock at Milwall, 30 miles above Killaloe. This lock has a fall of 60 feet, and its lower is the Athlone Lock. From Portumna to Killaloe, the river is broad, deep, and sluggish, requiring only one lock at Milwall, 30 miles above Killaloe. This lock has a fall of 60 feet, and its lower is the Athlone Lock. From Portumna to Killaloe, the river is broad, deep, and sluggish, requiring only one lock at Milwall, 30 miles above Killaloe. This lock has a fall of 60 feet, and its lower is the Athlone Lock.
The Lower Lough, above 100 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 just been described.

The Boyle is navigable for a few miles of its course, and in connexion with the River 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 outline of 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 removable 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 Beoga, are both shallow, constantly capricious, and difficult of use, and the navigation on both is comparatively deep. 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 much smaller expense than has been already estimated.

The Boyne, flowing for the most part through the flat and fertile county of Meath, seems to possess 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 removable. 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 15 feet wide, in their chambers, and are thus capable of admitting barges, or even small screw steamers, carrying a considerable burden. Its tidal estuary is extensive, extending 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 Kilkenney 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 inexpressible 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 1900 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 considerate volume of water into the sea at Youghal, and the ripability of the portions of its course, rather than an insufficient supply of water, has been 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 would be hoped the existing attempt 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
sarely 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 it to a short time, in the round of the circle of registered stations. The great success of these boats is, undoubtedly, attributable to their 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 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 opening 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 undertakings. This remarkable act is entitled, "For the draining and improving the Bogs and unprofitable Low Grounds, and for easing and dispatching 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 co-ordinate 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 Bruma, 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 Munroes in the Bog of Allen. To this reference has been already made.

3. Improvements of the rivers Glynn and Bean, from Newry to Coleraine. The portico between Lough Neagh and the sea has been finished.

4. The Nore and Bruma navigation, from the junction of the former with the Barrow to the Grand Canal near the Shannon. Several other works and other works have been made in connection with the Nore, but this line has not to have been abandoned.

5. Improvement of the Liffey and Creeves from Dublin to Killullen and Carlow. The Branch of the Grand Canal known as the Kellyare 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 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 Connacht. 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 Fortumna on the Shannon, [unattempted.]

16. From the river Inn, from Lough Shellyin to the Shannon, [unattempted.]

17. The river Suck, from Castlerea 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 Kinsea to Dummerway. 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 1718 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 85th 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 amounts were required to be granted by the commissioners for any years the commissioners had expended the sums placed at their disposal on the Newry navigation. In 1749 their expenditure amounted to £8,400. After this they commenced other works on the Boyne and Shannon, the expenditure on which, in 1756, amounted to £140,000.

In the 37th 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 1750, and received improvements in 1810. A new act was passed in 1845 for deepening it from Larne to a lock towards Belfast, so as to admit vessels of from 50 to 70 tons burden, 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 the opinion of Mr. Mac Mahon 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 project of the Grand Canal was lost. But it is not to the narrative of the Timblidge 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, being made in order to allow of private enterprise. For, while granting £60,000 for improving the Lower Shannon, the condition was annexed that 10,000 should be raised by private individuals, and in conformity with this arrangement the Limerick Navig-
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 established for local use only, such, for instance, occurred to the Newry Navigation, the Boyne, the Barrow, the Upper and Middle Shannon, and the Tyrone Coal Canal.

In 1798 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 8 per cent. for 300,000, the sum raised in one year not to exceed 32,000.

This liberal provision soon caused the following lines of navigation to be carried on, for which public money was allocated to the expense of:

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 Ternamunny.
5. The Boyne Navigation, above Drogheda.
7. The Erne Canal.
8. The Killarney Canal, to Nass and Killencullen.

The amount 35,000l. was further appropriated by the 31st of George III for the navigation and improvement of the Athboy branch of the Grand Canal, the Grand Canal docks, the Foyle Navigation to Strabane, and the Colliers Canal. From a report of the commissioners of accounts in 1790, the corporation for promoting inland navigation in Ireland had disbursed of Public Grants ........... 407,690 9 1 1 Income for Duties ...... 149,658 6 6 £557,347 11 8

At the Union in 1800, a sum of 500,000l. 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 423,790l. 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 27th of George III. cap. 34, 300,000l. 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 exertions of engineering 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 510,750l. and, in addition to plans for mill owners, land owners, proprietors of fishery rights, &c., reached the sum of 74,054l. 6 4d. 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 ampley 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 waterways.

Of the first which deserves particular notice, 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 Colleraine. 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 navigation 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 but aagg. or very small, the practical utility 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 Mespilick, 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 is, 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. Mulvaney, we assume the maximum discharge at Killaloe to be one million of cubic feet per minute, and the minimum quantity, to be half that amount, or 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 supplied by a smaller number of the large locks than is at present of the small locks. On the Leeds and Liverpool canal, where the supply of water is comparatively limited, six locks rise together 86 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 2000, 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 on 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 combination of the steam packets 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. Mulvaney. Although in 1838 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 170,000l. 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 targes.

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 of the Shannon, in the Lower Bann towards Colleraine, 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. 92.

In the present paper was written at the time it was 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 Drumlanago, passing through the town of Ballyshannon, or, as it is now called, Ballyshane, and thence via Enniskillen and Belhartra, thus giving to the former town the advantages of a better line. We have not as yet been able to get any facts 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 vessels of the possible lines of navigation, especially in the lines of the Conamville lakes, and in the southern Blackwater, for want of dining and living room equipment that may be deemed necessary. 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 traction or propulsive power? 2. What kind of vessel would be 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 length three times the beam. This is the form called the 'fuselage,' or the normal section of vessels intended for shallow waters, from which only slight and indespensables deviations should be permitted. Such a shape, combined with lightness of materials and general structure, would entail only a very small draught of water, and considerable difficulty consists in combining these conditions with such lines as would permit least resistance to the motion of the vessel in a narrow channel, or which would give the smallest value of K, in the formula:

\[ R = \frac{K}{\rho AVH} \]

where \( R \) is the resistance, \( A \) the area of maximum immersed section, \( H \) the draught, \( V \) the velocity, \( \rho \) the density of water, and \( V \) the resistance for the form given by the formula.

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 \( K = 0.06 \). The same values for ordinary shapes are 0.08-0.09. For canals and the shallower or narrow rivers of the interior, and those that branch off the impelling streams of the vessel on the confined and shallow, the velocity of which is a function of the depth of the channel. It moves most rapidly in small channels, and slowest in shallow water. This is necessary for the vessel, and enables it to go anywhere in the depths of a channel, a country needing posterior depression follows. In shallow water, when a vessel is backed at the wave, an increased submersion resistance is presented to the 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 she would be subjected to the usual resistance. A boat moving in shallow water will sometimes take up as places where she would doff 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 travel by means of the depression caused by the velocity of motion. By lowering the velocity, the height and depression of the wave would also diminish. When two boats are passing each other the effect is most sensible, as the resulting depression is equal to the sum of the depressions. This would continue, I have frequently observed, to cause their speed at low water in tidal narrows, 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 means of affecting the change. In wide and deep channels, the requisite impelling power increases with the depth, but the same result is produced in the same 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 minimum power necessary for each branch of the river, and when the routes that run from New to Angara were stopped from want of water, she was placed on that portion of the river, and was said to have soon realized the cost of construction. For the purposes of the river, and when the route that runs from New to Angara was stopped from want of water, she was placed on that portion of the river, and was said to have soon realized the cost of construction.
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 and cumbersome. The vessel, when under way, is forward to its head, and is propelled by a kind of floating steam, analogous to the railway train on land. It is intended chiefly for the shallow and windless rivers of India, but as some of its details may be suggestive of improvements in vessels for combined coal and river navigation, it seems probable that it may be extended to the transportation of goods.

**The Mints of the United States.**

By Prof. W. L. McKnight.

This transmission of gold from the new states of California has caused a corresponding increase in the gold currency of the States. A mint has been established in San Francisco, and a branch mint at Jacksonville, Florida. The mints are managed by the government, and are under the direction of the Treasury Department. The mints at San Francisco and Jacksonville are in operation.

The head establishment is at Philadelphia, and is called "The Mint." There are three additional mints: "The Mint," the executive staff consists of the director, treasurer, chief engraver, assayer, and two assistant assayers. At the New Orleans Mint, the staff consists of a superintendent, treasurer, chief engraver, and two assistant assayers. The several duties of these officers are performed with skill and efficiency.

At the United States Mint at Philadelphia, the salaries are fixed as follows: Director, $3,000; treasurer, $2,000; chief engraver, $2,000; chief assayer, $2,000; assistant treasurer, $1,000; assistant assayer, $1,000. At the New Orleans Mint, the salaries are: director, $3,000; treasurer, $2,000; chief engraver, $2,000; chief assayer, $2,000; assistant treasurer, $1,000; assistant assayer, $1,000. The several duties of these officers are performed with skill and efficiency.
attend to two furnaces each at the same time, one to one furnace and washing grains, and the remaining two to labouring assistants. The whole deposit of $3,000,000 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 not granulated), or anyway on the fourth day, they are granulated in the proportion of one part of gold to two parts of silver. The pots contain 60 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 smelters and two aids), there are ordinarily ready melted per day, but when hurried, forty-eight melts can be made melting as much as one-third million to one-half of million 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 molten metal is charged into large pots, together with pure nitric acid of 38º Baume, 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 ½-inch sheet-lead; a single coil of copper pipe passing around the bottom of the vat blows the steam 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 fire connecting with the chimney-stack, so that when in action the colour of nitrous fumes is scarcely perceptible to the eye. The $3,000,000 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 adding of nitric acid. 

The 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 filtrations are made in 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 44 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 beneath it. A tube with a false bottom, 2½ feet in diameter and 2½ feet deep is made, and the metal, after washing, 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 pure metal, and casted 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 coiners the same day. On the fourteenth they are ready for delivery to the treasurer and coined.

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 wood, and the first part back; the filter, which is on wheels, is then run over to the red mud, 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 absence 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 reposè the solution of mixed sulphate and chloride of zinc is run off into the sewer.

About 3 tons of zinc per $1,000,000 of gold are employed; the silver, however, in this amount, say 10 per cent. by weight, should contain about $400,000 or 10 per cent. of silver in 1 equivalent of silver are used. This is found to be advantageous, as both time and space are greatly economized by this excess.

The day after the reduction the reduced silver is washed, and the second day it is prepared dried by heat, the same hammers and washers in consequence used 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 ($3,000,000) of gold, the first-third of which is delivered as coin in fourteen days after its arrival, and the third-third in eighteen days.

As there is a bullion-fund of $5,000,000 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 17 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 smelters and 5 assistants. The total number of hands in the melting, parting and refining departments is 24, including a melting and parting foreman, and 3 in the place for grinding, sullying, washing, and sweeping. This last place or sweep embraces all pots, sahes of fires, trimmings of furnaces, sahes of all wood-work, &c.

The late law for reducing the weight of silver coin necessitated about 30,000 pounds in consequence of its being 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.

Many experiments upon anthracite, Professor Birch stated that he had at length fully succeeded in employing 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 anthracite—hard pine-knot coal—is 18 cents per bushel, delivered at the Mint; and while the cost of this fuel for all their operations in 1848, when gold was chiefly refined and melted, was about $700, the cost of anthracite will be from $90 to $100. In using the anthracite he found that a simple draught of air, without a blast, was sufficient to sustain the fire.

California gold frequently contains the alloy "iridiceme," which is not always detected by the assayers. 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 tonguing (melting fine gold and copper). If the assayers report its presence in the tongued bars, they are again melted, and the iridiceme allowed to subside. By these three, and often four successive melttings, the gold is separated from its troublesome companion as far as practicable. The gold thus refined is not of sufficient fineness (Section 9: "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 coinage 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 steam-pressure; it is a double vertical high-pressure engine, with coupled cylinders. The power is delivered by a cast-iron belt, 3 feet wide, from a drum 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 necessary in such delicate operations, a governor and throttle-valve of a design recommended by the men who have been employed, have been added, 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 when taken from that heater, are wound with a close 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 39-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 3-inch, at the rate of 200 pieces per minute, which skilled hands can readily accomplish in a short time. The punching during the rolling of the ingots into slips is performed in copper cases, in muffle fire-clay and brick, heated by anthracite coal, three muffles or hearths being kept at a bright red heat by one fire-clay or furnace, and the distribution and intensity regulated by dampers. These furnace cases are recent in this respect, and are very satisfactory; 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 covering of wood sawdust (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 300 and 500 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, being cast upon the coin 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 United States Mint.

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 dimes, half dimes, 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 74 per minute, but the rate can be increased if required.

If all the presses were employed in coining at the usual rate, they would strike in one day (6 working hours) 439,480 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.

In 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 United States importance, and these have been turned out of the "progression lever," "le genou" or "toggly 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, and where the sides of the blanks or planchets are 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 sifted in roulette rows 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 labor-saving devices. On the most curious account 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 into a given number of parallel metallic plates dissected into its planes 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 joint opposite to a given number. One of those employed by this department counted 1000 pieces, that is to say, it had 56 parallel grooves or rows sufficiently long to receive 45 pieces.

Now, having thrown on this board a large excess of pieces, it is again divided by shaking until the greater number is collected in thecliued 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 46 pieces in the length of each row. This operation, somewhat difficult 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 had 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 interior accidents. This operation was specially 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 Poole.

The balances of the Mint of the United States have received the attention necessary to an instrument of such importance in mint business. They have been given a form and arrangement generally 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 am particularly interested to mention improvements in those of the high-powered balance, which three or four improvements have been made by including 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
THE LIGHTHOUSE ON THE NEW SOUTH SHOAL, NANTUCKET, U.S.

REPORT TO THE SENATE OF THE UNITED STATES, REPORTING ON THE NANTUCKET LIGHTHOUSE

TO THE HON. C. M. CONRAD, SECRETARY OF WAR.

Sir,—In obedience to a resolution of the Senate of the 32d ult., I have the honor to submit the report, plan, and estimate, in reference to the construction of the light-house 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 of 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 light-house is $322,756.78.

For the beacon $34,664.73

And in the second $190,889.90

And in the third $187,630.91.

These facts, 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 light-house, 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. ABBETT,
Colonel Corps Topographical Engineers.

Bureau of Topographical Engineers, Washington, April 14, 1850.

TO COL. J. J. ABBETT, CORPS TOPOGRAPHICAL ENGINEERS.

Sir,—I have the honor 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 land 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. They rise from the ocean 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 15 fathoms. The direction of the currents through the group is generally 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 N.E. the first, to S.E. the last quarter, veering round to the east by the south; the ebb, the western quadrant, from S.W. the first, to N.W. the last quarter, veering round to the east by the north. Their greatest velocity is 24 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 course are subject, 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 fog, the influences of which are felt on 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. 45° N., and thence due north another 45° nearly as far as the mouth of the Harbor River; a line drawn between the same points, N.E. 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 Chespeake incline more to the north, and hence lines from the points to the Harbor River cut off, 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 fogs, in danger to which they are exposed in particular, increase 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 not only be beneficial to the trade of the coast, but would be of advantage in preserving the safety 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 vessels, especially 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 in:

1. The British American and European trades, from all ports south of Nantucket, as far as least at 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, E, also appended. It is confined, as sufficient for the present purpose, to the principal ports of New York, Philadelphia, and Baltimore.
within the 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 $293,346,366, and paying in duties $29,068,554, and carrying, without taking into account outward-bound passengers, of all classes, 256,000 persons, valued at $13,193,727, 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 whole trade is interested in pointing out the positions of these shools, can only be determined with anything like accuracy by tracing the course of each vessel engaged in it. But, here, is the coast of Nantucket, the position of the vessels 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 shools has to the usual course of the whole 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 6th of September last, as consisting of 66 vessels of all classes, with crews numbering 14,538 men and boys, and having a tonnage of 486,222 tons, valued at $7,854,850. The second, the arrivals of the trade for 1831, footing up as follows: vessels of the four classes, 239; crews, men, and boys, 5599; value of vessels $2,999,340, 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 whole trade, having a value of $13,178,124, and manned by crews numbering 5599, is exposed in a single year to the dangers of these shools. 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, however, is not in 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 above given, and dividing them by two. It is right to remember, that these are net values, 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, 5599; and the value of vessels, $2,999,340. 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 not more than those that occur when ports 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 ports of New England should be united to those of the Inner coast, 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 errors must be assumed. But this result does not, of course, 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 even to pass the Crem Rip light-boat, stationed in Vineyard Sound, some 12 or 16 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 of the commerce to the authentic statements under the first two heads—that is, to those having reference to the foreign and whale trade—it appears that 84% of the vessels were men, boys, and children, valued at $6,262,876 persons, and valued with their cargoes at $286,483,760, and paying in duties $26,688,054 (being more than one-half the entire revenue of the country from this source), pass and are exposed to loss by these shools 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 trade 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, any person, by any means, is capable of estimating, the amount 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 shools.

The foregoing statements and remarks give a general idea of the great importance to commerce of pointing out, at all times, the several places where the dangerous shools are situated, for, in my opinion, as 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 $323 per ton; or, for one of the largest, say $675,000. By the present scheme of sailing, the four lines make altogether 136 trips annually, passing, of course, the Nantucket shools 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 $43,673,309, 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, every time 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. But, looking at the whole, and on the assumption of 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 $231,376 50 and $239,070 80, respectively. Thus it appears that, besides the very heavy loss of 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 shools.

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 losses incurred by the outward-bound trade, than to those of any other; and the dangers in the dangers which at present exist between the inward and outward bound trades, so far as these dangers arise from the Nantucket shools, is owing, it will be remarked, not so much to the intrinsic difficulties of the navigation of the latter class, but to those arising from the uncertainty 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 Lenora, on those shools, within little more than twenty-four hours run from their port of departure,
New York, would, no doubt, be 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 hazards and complications 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 the New England coast, and then run down 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 they the least feared by the navigators of sailing-vessels; they are largely shared, notwithstanding the usual expedients 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 the less proofs of the literal correctness of the observations 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 South Shoal, by the shores of the most seaward shoal of the Nantucket group. It lies out of sight of land, south by south-east of 42 miles. It is composed of fine white sand, quite hard and compact; the least depth of water on it at mean low water being 8 fathoms. It is so situated and so 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, are generally more or less across it. It is exposed on the north side, and is, from exposure to the sea and the waves, the great desideratum in founding works on submerged soils exposed to the batter 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, proves 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 less certain. To provide a base of sufficient size and strength to sustain the necessary superstructure, that shall at the same time be capable of adjustment to the varying conditions 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 Mr. Lewers' patent. The investigation of this subject, therefore, inquired 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 screw 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-pile; 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 Wye; on the shoal ground off Holywood, Belfast bay; and, in this country, on Brandywine shoal, near the Delaware; and in the case of the light-house from 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 north, when the piles were properly inserted, and the diagonal stays attached. The design to raise a beacon of screw-piles on the eastern end of the
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL

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 found that their descent had been three feet short of the depth required. 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 soil but had taken its natural descent. The scree and its supports, therefore, served as 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 at the uniform size, the penetration by the screw 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 upper part 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 those circumstances, capable of immediate use in a given part of the Thames estuary, 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 Swing channel, at the southeast point of the shoal ground known under that name, and about 36 miles from the shore, where the Thames expands to a width of 30 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 that structure, had to be driven into the sea-bottom by a ram, to a depth of 32 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 16 mile distant. Though open towards the sea for a considerable area, it is protected from its roll by large areas of wooded land, and is therefore of a very sheltered character; but it is not the "soft sand" of Maplin, as described, but of a much harder description than at Maplin," and that the screws of 3 feet were "sunken 13 feet into the bank." Another, that the entire penetration was but 10 feet; the first 7 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 advantage for such an experiment as at Maplin. 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. In the cases of the road and the breaking seas at Holywood, this 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 structure by the screw would not 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 aforesaid, 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 keep them at their descent. This was the case of the Tongue 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 13 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 considerable combination." 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 in the case of that of the site of the Wyre light in a comparatively and not a positive sense. This probably is the true explanation, as accounts for whatever success attended the attempts to apply the screw-pile at the Tongue 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 those 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 secured the same effect. The proofs of the impression are as resounding as the sensible 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 that has been described as the limit of the constitution, 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 Brandywine and Holywood are alone relied upon in support of the opinion contained under the last 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 3357 feet, and consumed 74 days of the working season. 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 8400 feet, and would be elevated 38 feet (as will be shown hereafter) above the bottom—that is, it would be about double the road 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 equal to 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—as assuming even the most favourable view of the case, and taking no account of very exceptional and abnormal circumstances—a distance of 13 to 45 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 133 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 adverse weather conditions. 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 far less 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 must be to be at the point to be at Brandywine shoal was 23 ft. 8 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 high-water mark; and lastly, 4 feet for height of the capstan drumhead employed to drive the screws abode the floor of the same. It was the original intention to insert the screws in the shoal for a depth of 10 feet; but it was only after the most strenuous exertions, with a force of thirty men working the machines above mentioned applied to a spur and pinion wheel attached to the shafts of the screw, above 15 feet above the water; 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 built on the reach of the sea should, under these circumstances, be at 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 sort as to make the capstan drumhead of the platform, including 2 ft. 3 in. for the thicknesses, would be 35 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 much 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 foundering 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, according to 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 23th December last, may be safely ventured on, conclusively, particularly as it is supported by cases of application in the erection of 20 foot ice-harbour, made in other 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 purpose to recount merely the following instances in which piles of this kind have been used in connexion with length and diameter considered, would seem only limited in their application to the power under the circumstances to handle them.
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 depth of the water consists in the shallowest 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 about which, when raised, be founded in the sea, to resist the shocks of the ocean, a 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 moreover the soil excavated 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, grouped together as to form an octagonal prism 50 feet in diameter, and about 45 feet in height. From this prism, as a base, rises a truncated pyramid, composed also of iron piles, which inclining inward 6 to 1, for a further height of 120 feet, fall within the diameter of 30 feet, and are penetrated and 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 8 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 water, 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 height; the former 6.8.9 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 frustum of the larger structure. The cage, the bottom of which is 50 feet in diameter, and the top, 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 104 feet.

These are the outline and 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, &c., 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-hall, the keeping of the oil, water, and fuel, &c., and all other particulars, even to the size of the material employed, &c. Tablo-types of the elevation and vertical section of each, reduced in scale to about 1/80, 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 for insertion, was obviated. But it is now seen, 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 lighthouse, under the circumstances, at so exposed a point as New South Shoal, at least in the time in which it was considered 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 section of the structure described as the octagonal prism, and by Dr. Potter'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 adequate strength, whereas, if the piles were lower in 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 excavated, and, 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 1 inch, which will be deposited in the office of 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 326 tons. To receive and float this great weight, distributed as it is over such large bounds, will require twin-camels, each about 100 feet in length, 153 feet beam, and 10 feet depth of hold, or say about 160 tons. These camels, when light, will draw little over 34 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 45 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 inaugurate full efficiency to the proposed arrangement; to which 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 easy 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 28-3 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, 486 tons; giving 71-1 tons on each pile, or 2-6 tons on each superficial foot in the case of the first, and 61-4 tons on each pile, or 2-6 tons on each superficial foot in the case of the 100 feet in length of the shorter 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 per ton. The added advantage of the pneumatic piles, in the case of the shoal, would in the case of the shoal, would be exhibited, if 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

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

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, 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 light-house 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 site; and the next season at the site. 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 must necessarily be offered, in outline, of what would probably be the course in regard to that measure. It is not further to be considered, 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 3/4 feet at low water at the entrance, the next stage of the tide could not be 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 would be, considering the dangers of the trip, and the time the sails 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, in the roughness of the weather, it would be 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 2/3 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, should require the least time to accomplish. As the plan of the work is based on a regular figure, and must 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 raise themselves removable as the tide falls. 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 the task. This includes putting a ship's force, the air-pump, by excavating the sand under the piles through the tonns 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 accounts. Running much as follows:

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 out, 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 consume the most complete design of the work could be justified by the large expenditure as that involved, the very idea is one 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, Eddytoune, Bell Rock, and Skerryvore, the last only was built after the introduction of steam-navigation. Mr. Allan 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 entrance to such a vessel as the Phoebe—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, the operation must be estimated at the length of time required for building the Skerryvore light-house with a sailing-vessel, I should say we must still (even in 1846) have been engaged in the masonry part of the work, which was commenced on the 26th July, 1842. The steamer employed at Skerryvore was of 135 tons, with two engines of 50 and 60 horse each, and cost completely fitted (5930L.) 8,650L.
An alteration in the engines by raising the shafts, &c., increased this (435L.) 2,115L. Repairs on the hull and engines during the progress of the work (1057L.) 4,958L. Sailing expenses (800l.) 55,058L. for each of the four years, 1842 to 1845 inclusive, 216,508L. This item should be partly accounted for, out of 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 compar-
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's, 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 Stuckey,' a tale abounding in powerful passages, and displaying genius of the first order. The Times it was generally understood that Mr. Phillips was possessed of a technic enriched its column in the winter season. Their greatest merit was the mastery analysis they presented of the media in which authors produce their effects. In this species of exposition, Mr. Phillips had no superior.
ADDRESS TO THE ARCHITECTURAL ASSOCIATION,
LION'S-INN-HALL, OCTOBER 9TH,
By THOMAS M. RICKMAN, President.

Is 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. This is the fate of those who are young desirous to advance in knowledge, and also, looking at certain bright examples of architects, as well as 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 field of intellectual and moral achievement. And, as all 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 unappreciated 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 repose to their labors, 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 more sentiment of their occupation. I have no hopes of improving 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 moral, stone, canvas, or language, that conveys the impression to our senses, is but a reflection 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 its tastes will be shown by the line of study we adopt. We study, for it is our business; and we make our business, our knowledge, 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 generalize. Their position is not that of a political theorist, for the theories which they develop are those 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, I think, have grovelled in the art and without occasion most serviceable hints for our consideration. They shine, however, most when, in critiquing a building, they lay open the secret workings of the architect's soul in the design. They oftentimes use an architect's work as a parenthesis which would his head, and, judging by their own standard, detect the moral, intellectual, and other qualities 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 induce us to have influenced our minds, but 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 rule of the age, and ever has been. The architect who is not conversant with the position of an architect, which renders 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 in architecture, the opinion of the masses and the public interest are so connected that it is impossible for an architect to escape criticism. The highest aims of the architect, and in this sense of architecture, which the mass of men and the public interest are so solemnly attended to, that he may in his higher moments recognize in the works of the great architect of the age he has 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 most rare man can contain.

But in the present day, is it possible for the architect to devote his attention to the mastery of those 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 the time to examine the historical principle 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 indispensable to the study.

The position of this knowledge of materials is not that of the abstract study. The one is not to be isolated. The one is not, even in his own works, the aim of the architect; nor does the use of the material and the class of minor best adapted for its disposition, constitute the object of his practical efforts. They correspond to the grammar and logic which are adapted either by natural precept 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 the right line, which are appropriate 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, make the whole arrangement by himself; his advancing taste, what are the parts which harmonise the one with the other; and we shall be led to believe that these analogous contracts and likenesses tell of a relation subsisting among them all; and to contemplate an all-pervading principle, first in man to have the thoughts we have for treatment of art; a connection elevated to our view of the forms, honours wish to convey impressions of the last, 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 contain 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 finity 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 express the thought, and express the thought, and express the thought, and express 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 cultivation of art for his own use—enables 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 must tell of the action of which materials are capable, that is, motion. All our forms are therefore motion, and pure or combined. In practice the simplest forms are those always used. If we rely upon action, it is in its attributes its coherence that this simplicity is visible; and even then is it so evidently that action is the basis of our universe, art can be seen on the surface of our earth, the kind of the form and the action of the form are for a finite and external work. The mode of its execution we cannot divine; the arrangement of its means of action are hidden from our sight. Its beauty is its possession 0f power not to act upon other objects. The beauty of its surface is that of the dormant energy of every member waiting but an incitement 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 from adventitious circumstances, this before we may take its place as a guide; because every 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 when we refer to form 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 with the three dimensions of the object, and their contrast, strongly akin to chemical laws. But will the study under this aspect exhaust the interest we derive from colour
THE CIVIL ENGINEER AND ARCHITECT’S JOURNAL.

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 in each, and the soul which is capable of their ducings, 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.

With artists, in every sense of the word—classical, and, specially, vegetable forms, as exemplars ready to hand of the results which, in an 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 means of this manifestation 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, by leaning upon a more exact image of a natural form, they at the same time fulfill 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; ornament; making pictures of the beauties conveyed by 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 every artist can call it—the form which the plant is 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. We shall perceive a real map may depend upon being understood 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. More and more, the parts of ground. More and more, the parts of the structure, and the parts of the mind are separated. It is not difficult to form a study, not upon a broader basis, but accessible only to the initiated, a field wherein 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 honor of addressing to you, the 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 we have arrived at the mind of that deeper symbol, 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 scenes, in the representation of any form having fixed and definite 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 professional artists, to carry it to perfection. In the meantime, being asked my opinion, I, 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, pictorial representation of a place, district, or country, in its natural state of ground, river, 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 pictorial exhibition to the eye. It should be such as to exemplify Dr. Wallis’s principle, that the geographer should illustrate 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 every artist can call it—the form which the plant is 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. We shall perceive a real map may depend upon being understood 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. More and more, the parts of ground. More and more, the parts of the structure, and the parts of the mind are separated. It is not difficult to form a study, not upon a broader basis, but accessible only to the initiated, a field wherein 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 honor of addressing to you, the 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 we have arrived at the mind of that deeper symbol, 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 scenes, in the representation of any form having fixed and definite 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 professional artists, to carry it to perfection. In the meantime, being asked my opinion, I, 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, pictorial representation of a place, district, or country, in its natural state of ground, river, 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 pictorial exhibition to the eye. It should be such as to exemplify Dr. Wallis’s principle, that the geographer should illustrate 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 every artist can call it—the form which the plant is 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. We shall perceive a real map may depend upon being understood 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. More and more, the parts of ground. More and more, the parts of the structure, and the parts of the mind are separated. It is not difficult to form a study, not upon a broader basis, but accessible only to the initiated, a field wherein 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 honor of addressing to you, the 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 we have arrived at the mind of that deeper symbol, 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.
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 man may lose of which the means and resources of art, in the present day, may supply to 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, economic, 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 one, and although 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 greatest difficulty of the work; for while in the map the eye embrace whole field as a glance, it is supposed to travel over the whole surface of the earth, which is variously fixed as a map, and 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, etc., to be added to it. Yet the whole may be worked out with a pictorial 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 expressed, 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-draughtman 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 most difficult, and, in the present day, presents no difficulty at all of more delineation. It is the whole method based on the most artistic ideas—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 being the painter's art in it, the object of which—has been supposed more "to please the eye," than to express the true idea, 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, pictorially. 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 geometrical, the mechanical, and that only accurate delineation is better for it, and more useful, than pictorial expression, it may be answered, that both may be combined, that this eye demands natural drawing for natural subjepts, and that it is, in fact, in some way or other, always attempted in nature of the kind; sometimes, indeed, absurdity 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, and to 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 geologist or the ordinary land-surveyor, should be an artistic draughtman, though in their proper measure, both may add this accomplishment to their respective abilities; yet it seems more proper to belong to the latter profession to cultivate it; than to the mathematical and philosophical ability which is occasionally called into action for geodetic purposes. Indeed, the land-surveyor may aspire to the higher branch, perhaps, more consistently than the less constant and easy. He 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 elegance and grandeur.

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 forms of volcanic origin out of it; its division by ranges 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 these aspects as a basis, 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, a close similarity of an analogous geological configuration, as seen from a map properly representing it," its geological structure may be inferred, at least to a certain extent. The whole mechanism of forms and of geological configuration in the British Isles, or perhaps more so, when these have been sufficiently surveyed in relation to this great geological 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, 1835, assumes that the structure of those eastern regions is composed of three sets of formations at the same time; hence the zigzag disposition in horizontal order, of the mineral masses, and the rim-like forms of their surface structure; the hollows forming the channels by which currents of the northern flood passed over the land in a southerly direction. The liming forms of the coast-like escarpments which front the north, and 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, 1836, 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 oolite beds are the remains.

The 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, at least, the physical distinction of natural races. He should apply them to landscape-drawings, and in that perspective which approaches nearest to the plan view; and in addition to mere manual skill, in delineations and coloring in relief, he should learn enough of the principles of pictorial art for his government and use, and study their application from paintings which furnish examples of expression coming nearest to that to which he aspires, and the 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 geologist or the ordinary land-surveyor, should be an artistic draughtman, though in their proper measure, both may add this accomplishment to their respective abilities; yet it seems more proper to belong to the latter profession to cultivate it; than to the mathematical and philosophical ability which is occasionally called into action for geodetic purposes. Indeed, the land-surveyor may aspire to the higher branch, perhaps, more consistently than the less constant and easy. He 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 elegance and grandeur.

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 forms of volcanic origin out of it; its division by ranges 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 these aspects as a basis, 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, a close similarity of an analogous geological configuration, as seen from a map properly representing it," its geological structure may be inferred, at least to a certain extent. The whole mechanism of forms and of geological configuration in the British Isles, or perhaps more so, when these have been sufficiently surveyed in relation to this great geological 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, 1835, assumes that the structure of those eastern regions is composed of three sets of formations at the same time; hence the zigzag disposition in horizontal order, of the mineral masses, and the rim-like forms of their surface structure; the hollows forming the channels by which currents of the northern flood passed over the land in a southerly direction. The liming forms of the coast-like escarpments which front the north, and 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, 1836, 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 oolite beds are the remains.
dent, 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 ideas on the ground, as typical forms, for ready whole apprehension, and aids distinction of the natural forms. A nomenclature for the natural forms of land, founded on their similarity to the geometrical 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 Farrah, must be familiar to many observers of the late encampment at Chobham; and to some with whom I am in touch, on Eton 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 neutral 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-timbered hills, dissected by a single or multiple gullies, are bold examples of this form—trap-hills, the siurian 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 1843. "The mountain 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 20 to 30 miles. This high land consists of a single core, or large block, 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 blocks, united by connecting chains, and into which we may go to obtain the tabular summits. When seen from the low ground, the mountains have an apparently very complex or irregular arrange- ment, 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 greywacks and clay-slates. 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 have described, is a segment of a sphere, and will be seen when understood more than the mass, that is to say, when the sub-volumes displayed in the map-view is a true and perfect representation of 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 carefully preserved in the map-view.

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 pictorial map-drawing can give, expressively and immediately, to the eye. Nevertheless, Mr. Miller expresses, in words, pictorial ideas of landscape 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 betray the presence of hills. Each has its "type of landscape"—(and plan-shape and style, too)—"and as the vegetation of a district depends often on the nature of the underly- ing 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 coloring of the landscape"—(and the plan)—"is well understood when 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 reproduction in map-drawing is a fine lesson for the map-drawer to take and illustrate. Biskin, 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 characteristics of every species of being, down even to the stones; for there is an identity 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 gratifi- cation 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 of thought all hill lines of nature, but it is not to be reduced to line and rule." "Turner's early drawings are interestingly instructive in definiteness and simplicity of aim; they are little more than exquisite studies in light and shade." This, I think, should 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 relief." This, I think, is exactly what I should say for the shading planes of ground in relief.

The term form is not to be applied to the outline of bodies; "it inevitably 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 objects to the eye 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 pictorial 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 satisfaction to the eye; and what is beautiful in a richly varied face of country may be beautifully portrayed.

It may perhaps, be remarked, that this view of topographical plan-drawing does not admit 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 pictorial quality drawn, seem to me to compass the proposition. The cause of this kind of drawing being besides 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 pressed and required to address the mind with great 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.*


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 beveled 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 bevelled form to the oval end of the beaver, by paring it upon a stone, and 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 bevelled 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. Thom. 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 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. Thom. On the whole, his brushes are regarded by the Committee as superior to any other article 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 endorses 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 alignment throughout the ridge of the 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 spand 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.

**GRIBBON'S PATENT SASH-MOUNTINGS.**

**HINCES AS AT REST**

**FRONT OF HINCES**

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 bend 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 1863-64:

A Telford Medal, to Nathaniel Beardmore, M. 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 Pigot Smith, Assoc. Inst. C.E., for his paper "On the Principles and Construction of Locks."


A Council Premium of Books, suitably bound and inscribed, to Daniel Kinnee Clark, Assoc. Inst. C.E., for his "Description of the Deep-Sea Fishing Steamer Enterprise, with its Propeller."


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-Metres."

The Meetings for Session 1864-55 are appointed to take place on the following Tuesday evenings:—In 1864, 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 Prizes.); 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 Conversations will take place.
IRON ROOF OVER THE PROVIDENCE MAGAZINE AT PARIS

Fig. 2. Support to Sky Lights.

Fig. 1. Transverse Section.

Fig. 3. Support to Sky Lights.

Fig. 6. Section at A B. Fig. 4.

Junction of Rods with support Band.

Scale for Fig. 1:

1 2 3 4 5 Meter

J R Johnson
PROVIDENCE MAGAZINE, PARIS.
M. KAVEL, 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.

Six—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 1000l., 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 Mr. 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 clerks, 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 connected with the company, and the Board was authorized by the General Board, before sanction was granted, for the additional mortgage.

A memorial, dated the 31st 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 Hirsell, 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 impaired in 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.

Dr. Roberts's complaints which are raised against them by Dr. Roberts are not founded upon any actual experience of defects, but upon the mereest 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, I am of opinion, not to a degree of danger from the intrusion of the river, for the junction 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 of Hirsel, and Dr. Roberts was not prepared with any evidence of this. His own statement of the extreme flood level in Hirsel is only that of "knee deep."

It is impossible to reconcile this discrepancy, but it would appear to be probable that the waters alluded to, as having been observed 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 Guarantee and the terms and conditions by which we are enabled to take waterworks company, 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 being entirely under the control of the Public Health Officer, 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 audit 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 Water Works Guarantee Company 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 100l. 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 of conduct.

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.
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 accommodation 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 sunshine.

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 forests.

5. The airy 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.

September 24, 1854.

H. A. A. T. T. W.
1011. W. Simpson, Birmingham—An improvement or improvements in beams or girders for bridges and other structures.

1012. J. Abson—Improvements in dusting and stiffening textile materials or fabrics.


1014. G. Thome and B. Lemons, Forest-street—Improvements in face-boards, signboards, or name-boards.

1015. W. H. Newberry, Chassey-lane—Improvements in tuning-keys for pianofortes and other stringed musical instruments. (A communication)


1017. S. Crabtree, Bradford—Improvements in machinery for combing wool, hair, and cotton, and for treating and dressing wool, hair, and cotton. (A communication)

1018. T. Lewis and A. B. Morris, Birmingham—Improvements in apparatus for purifying water.

1019. W. H. Dawes, Handsworth, Stafford—An improvement in the manufacture of wicker.

1020. G. P. Frey and G. Collins, Jollie-place, West, New-road—Improved apparatus for heating, boiling, heating heated liquids to boils, useful also for supplying heated liquids for purposes.

1021. J. Cunningham, Beech, Ayr—Improvements in the preparation or production of baking-soda.

1022. J. Porter, Saltford Screw Holzwirts, Manchester—Improvements in machinery for making Hundreds, engraving, forging, and forming rails, bolts, screws, and various other articles in metal.

1023. J. Kershaw, Bury, Lancashire—Improvements in beams for weaving and pitching.

1024. W. Gee, Birmingham—An improvement or improvements in the manufacture of beams or girders for bushing, driving, screwing, and other such work.


1027. W. Gurney, Leek, Lancaster—Improvements in and applicable to machinery for warping and dressing yarn or yarns.


1029. J. H. Johnson, Lincoln's-inn-fields—Improvements in ovens for furnaces for melting and smelting ores, and for the manufacture of iron or steel, and for the production of iron or steel.


1035. A. R. B. Bellfield, Castle-street, London—A new mathematical instrument, to be used by laymen, for 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)

1036. S. H. Iceland, Whit Glass Works, South Shields—Improvements in apparatus for the manufacture of vases, bottles for measuring liquids, and bottles for containing liquids.

1037. W. Sharp and W. Welld, Manchester—Improvements in machinery for winding, cleaning, dressing, spinning, and throwing of silk.

1038. A. A. France, Paris—Improved machinery for producing for pressing or calendering fabrics.

1039. M. M. Monro, Lease's Castile-street, Holborn—Improvements in hats, bonnets, and other articles.

1040. R. Holdén, Kingston-square, Hull—Improvements in apparatus for the manufacture of bricks, tiles, and other articles from plastic materials.

1041. G. Crofts, Derby-squa, Manchester—Improvements in the manufacture of bricks and other plain and ornamental fabrics.


1043. J. H. Johnson, Lincoln's-inn-fields—Improvements in machinery or apparatus for manufacturing compressed and compressed peat in the manufacture ofTI's materials. (A communication from F. F. Morris, Taras, France.)

1044. H. Holland, Birmingham—Improvements in the manufacture of umbrellas and parasols.

1045. T. Lawrence, Birmingham—Improvements in machinery or apparatus to be employed for the purpose of shaping and fashioning certain parts of bony article.

1046. P. Spencer, Pendleton, Lancaster—Improvements in obtaining sulphur from iron pyrites and other substances containing sulphur.


1048. W. J. Brown, Bristol—Improvements in a composition or combination of materials to be used for making vases and other articles.

1049. G. M. Smith, Glasgow—Improvements in saddle trees.

1050. D. D'Arcy, Marlesford—Improvements in gas-burners.

1051. H. A. Genest, Paris—An improved system of carriage-shafts, poles or beams.

1052. W. Marshall, Wapping, Pas de Calais—An improvement or improvements in metallic wheels for railway and other purposes.

1053. E. L. Spratt, Manchester—Improvements in locks.

1054. F. J. Chabot, Hespérides—Improvements in supplying air to furnaces.

1055. H. H. Rugg, Sheffield—Improvements for curtaining demountable frames. (A communication from A. H. B. A. H. Rugg, Sheffield.)


1057. W. P. Surjyn, Hackney—Improvements in cigars, cigarettes, and charred tobacco.
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 10l. 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 paling and 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-paned 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 coping,
weatherings, &c. The roofs to be formed of framed rafters, with
arched riba in the Episcopal chapel, covered with dressed board-
ing, 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:

<table>
<thead>
<tr>
<th>Tenderer</th>
<th>Amount (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Messrs. Johnson, Laceby</td>
<td>3277 17 0</td>
</tr>
<tr>
<td>George Emerson and Co., Louth</td>
<td>3267 0 0</td>
</tr>
<tr>
<td>John Dales, Louth</td>
<td>3274 0 0</td>
</tr>
<tr>
<td>James Miller, Tenterden</td>
<td>3200 0 0</td>
</tr>
<tr>
<td>Messrs. Brown, Grinshy</td>
<td>3039 0 0</td>
</tr>
<tr>
<td>William Johnson, Grinshy</td>
<td>1953 0 0</td>
</tr>
<tr>
<td>Messrs. Frie and Thompson, Brigg</td>
<td>1945 0 0</td>
</tr>
<tr>
<td>William Hollingsworth, Grinshy</td>
<td>1897 18 0</td>
</tr>
</tbody>
</table>

The estimate of the architects, submitted with the competition
design, for the same works, was 1858£.

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 of the bridge, and the proposal to add a new road to
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 necessarily 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 traveling
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 pas-
sengers crossing London-bridge annually, to and from, may be
seen, have been 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, the summer season, you have a vast 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 roads is 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
it is of bridges, or sewages 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
cost 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
so sure, if the money must be raised, that it is a worse mode of
levying a tax than a system of direct taxation; but that 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 699,000 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 10l. or 20l. a ton higher than they did. The construction
of new bridges would, of course, not be justified if the present
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 localities.

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;
instances once experienced 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 company with the railway station were improved. Erection
of a new bridge with approaches would not do. 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
the proposed improvements should be made. If a new bridge
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 side of the bridge. Has a great objection to
tax for building new bridges. The throwing open Vauxhall-
bridge would not be an advantage in relieving the city traffic.

TYRELL, 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 con-
sidered a contribution to the revenue, and should not be
looked upon as a good 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
freesing the bridges.

BRAND, FERDINAND, Comptroller of the Bridge-houses
Estates—The Bridge-house Estates consist of land, houses, wharfs,
warehouses, and other buildings which are held by the
Company 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 the estates
sold at different periods under the authority of various Acts of Par-
liament 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. Stephen’s bridge and the High-gate 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 to the state of the bridge by Mr. William Emery, and Sir
Burrage, and by Sir William Cubitt and Mr. Brunel, and on the
reference of them to the Court of Common Council they con-
cluded in the necessity for rebuilding the bridge. The Bridge-
houses Committee are at present considering a plan for widening
Southwark bridge. Negligent and imprudent amongst the directors
are the directors with the directors of Southwark-bridge for the purchase
of the bridge. The directors ask 300,000l. 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

average annual amount of the net dividends of the Southwark-bridge Company, for the fourteen years ending 1848, is about £2,700. He has no means of going lower than 1848. Now, suppose the thirty years' purchases, would amount to £88,000; taking it at forty years, would be £131,000. 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 or so as an experiment. The Bridge-house Committee do not at present think of the Somers Town proposal, but the Benjamin offer is a little more 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. Lainigat 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 delay any improvements by a rate, on account of its unpopularity.

BUNNING, JAMES, Architect to the Corporation of London. Presented the model now before the committee for the improvement 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 to more desirable to devise some means for the purpose of projecting parapets over the sides of the bridge, and neglecting 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 carriages; and by the 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 short of the channel, after the addition of a fourth roadway from 9 ft. 6 in. or 10 feet on each side. The centre line or division upon the mode 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 separate lines, it would increase the facility greatly. The estimate was £30,000; but the rise of material has been exceedingly great since then; he should think £90 per cent, and that it would cost now £36,000, including the new road. Independently of the footpaths, the roadway will be very nearly 50 feet; it is now about 30 feet. This addition would be carried out in iron. The scheme, he admits, would not improve the bridge. But the question whether, if required, such a mode of 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 extolled to the advantage of the additional roadway. It must be remembered 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 pressures which would be done away with; 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 provision for an increase at this 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. Dawes; it is now being worked out by Mr. Page. Witness had never heard of a bridge across the Thames from St. Paul's. Sometimes 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 £130,000; for the construction of the bridge, and £24,000 for the approaches on both sides of the bridge from level to level, making a total of £144,000. Since then that, materials as well as labour have risen considerably, and if an estimate were to be given now it would probably be £30 to £33 per cent. higher than it was then. The old bridge was proposed to be raised 12 ft. in height. If that instead of being 60 feet, it would be a wise economy to have it 80 or 90 foot 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 warehouses could not be erected of more magnitude of buildings, or 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 upon the site of the Temple and Blackfriars-Tower; this happens to be an old 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, 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 fostering. 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 no means of going to the City; they must go by the road, and drive 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 suggestion hitherto received; 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 completed, the bridge may be connected 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 the 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 might be executed at very little expense, and the line is provided for in the approach, but Mr. Dawes the designer is dead. 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 would spring from Walting-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 the best that could be chosen for the erection of the bridge here. Still for four centuries Walting-street existed; in adding 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 now a new street projected here; it is called New Cannon-street, 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 160,000; to 200,000. 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. If the same new street is proposed to be constructed for the purpose of taking off the traffic thence across the 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 a sort of man made hill; they have built a New London bridge, 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 versa, and from Earl-street over Blackfriars-bridge, and vice versa, 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 Blackfriars, which has been noted, is as follows: omnibuses 188; all other vehicles 965; making a total of 1153. 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 over Blackfriars-bridge are, 517, of which 517. Presuming that those 53 cars have probably come from St. Paul's Churchyard over 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 number may be put up to 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 takes from twenty to thirty minutes, the same traffic is approximately, I suppose, to be the same there to go to Elephant and Castle before it is 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 traffic hindrance. There is nothing that is calculated to add injury 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 six to 19 per cent. Certain, that the traffic in the streets is increasing at least 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 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 Tower-hamlets, 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 charol-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, and the entire accommodation of the wagons. 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 905,000, there were three bridges. In 1811 the population was 1,300,000, 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 we had 102,000 wagons being brought over London-bridge. By 1841, 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 2,361,940, and yet we have no more bridge accommodation than we had when the population was 905,000. 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, coaches, and omnibuses, the latter being unknown before 1836, demanding wider streets and more bridges. The present population is 2,700,000; the number of wagons being 300,000. 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 people that should be supplied with accommodations of the other streets, or 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 to Blackfriars and Limehouse, comes only to the north from there, and the south is in a traffic 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 crowding to London-bridge, and 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, sufficient to accommodate every demand. 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 Dockhead, 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; 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, 30,000; building the new bridge, 660,232; and the approaches, 1,846,436; making together, 2,566,282. 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. |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| London          | 8175          | 7874          | 6885           | 6707            | 6195           | 6180           | 6651           | 7773           | 7416           | 69,880        |
| Southwark       | 139           | 175           | 206            | 148             | 199            | 160            | 130            | 119            | 130            | 1,837         |
| Blackfriars     | 499           | 295           | 2925           | 3229            | 3143           | 3580           | 2566           | 3444           | 3114           | 20,039        |
| Waterloo        | 681           | 635           | 616            | 298             | 610            | 638            | 705            | 817            | 797            | 6,234         |
| Westminster     | 2640          | 2700          | 2880           | 2980            | 2640           | 2640           | 2180           | 2900           | 2900           | 26,170        |
| London          | 7560          | 6547          | 6708           | 7026            | 6843           | 7085           | 7291           | 7920           | 5081           | 62,880        |
| Southwark       | 26            | 16            | 13             | 4               | 8              | 1              | 1              | 11             | 18             | 93            |
| Blackfriars     | 8             | 9             | 9              | 9               | 7              | 6              | 5              | 10             | 10             | 35            |
| Waterloo        | 5             | 5             | 6              | 1               | 4              | 2              | 3              | 3              | 10             | 35            |
| Westminster     | 15            | 35            | 34             | 44              | 25             | 47             | 21             | 34             | 47             | 297           |
| London          | 1311          | 1368          | 1375           | 1395            | 1186           | 1393           | 1366           | 1429           | 1810           | 11,488        |
| Southwark       | 35            | 33            | 33             | 34              | 25             | 30             | 38             | 42             | 32             | 307           |
| Blackfriars     | 208           | 450           | 415            | 550             | 490            | 410            | 444            | 510            | 572            | 4,359         |
| Westminster     | 490           | 550           | 680            | 540             | 560            | 650            | 650            | 790            | 720            | 5,840         |

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 London on a level with Lyons in that respect, there ought to be 133 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 264,000 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 lower 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 3280 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 18,280 persons designed to be accommodated by the 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 costs 42,000£, another cost 36,000£, and the third cost 28,000£. 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 300 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. Twopenny postage 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.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>London</td>
<td>930</td>
<td>54</td>
<td>204</td>
<td>5</td>
<td>140</td>
<td>Granite</td>
<td>J. Bennie</td>
<td>Removing Old Bridge, £40,000 600,253</td>
<td>1,840,488</td>
<td>2,040,385</td>
<td>4°</td>
</tr>
<tr>
<td>Southwark</td>
<td>700</td>
<td>42</td>
<td>239</td>
<td>8</td>
<td>240</td>
<td>Iron</td>
<td>J. Bennie</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Blackfriars</td>
<td>908</td>
<td>33</td>
<td>274</td>
<td>9</td>
<td>100</td>
<td>Portland Stone</td>
<td>R. Myhne</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Waterloo</td>
<td>1250</td>
<td>40</td>
<td>35</td>
<td>13</td>
<td>78</td>
<td>Cornish Granite</td>
<td>J. Bennie</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Westminster</td>
<td>1220</td>
<td>40</td>
<td>35</td>
<td>13</td>
<td>78</td>
<td>Portland Stone</td>
<td>L. Layley</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Proposed, St. Paul's</td>
<td>—</td>
<td>60</td>
<td>37</td>
<td>5</td>
<td>240</td>
<td>Iron</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>

Average Width of Waterway, 800 feet.

by Mr. Brand, it appears that the Bridge-house Committee have now at their command about 230,000. They have borrowed 431,000, 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 laying of a rate; thinks it would be proper to have it 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 to 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 real 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 quarter of the city, and still more for the economy and convenience of our continental and colonial postages. 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 160 per cent. of its present amount, that there might be 353 feet. A favourable opportunity is now offered of raising 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 ascertaining 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. Preseumes 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 ease 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 30. On the Middlesex side, thinks the inclination could not be improved without a considerable outlay; it is now 1 in 20, not much steeper than Westminster, which is 1 in 23; a length in the approach to London bridge is 1 in 20; Ludgate-hill is 1 in 27, Vanhalla-bridge only 1 in 30. Does not know any improvement more desirable than an improved communication between the Surrey side of Waterlow-bridge and Union-street, Borough, there would then be a good communication all the way from Westminster 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 will be £300,000. There are two among 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.

Barlow, 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 undertook to adapt for Westminster-bridge, and submitted it to the committee; but the design having been decided upon for that, he has undertaken to adapt it to this. Retaining the three arches on either side, the expense would be £125,000, but calculating the whole bridge it would come to £300,000. 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 of the bridge from 70 feet to a little over 90 feet, 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 26 feet each.

MUNICH INDUSTRIAL EXHIBITION OF 1854.*

This 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-Kless, of Nuremberg. The site chosen was the northern side of the Botanical Garden. The length of the main edifice was 600 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:

* From the report of Cenys-Galandt Ward to the Earl of Clarendon. 1 sq. ft. = 0.093 m. 1 ft. = 0.3048 m.
1 florin = 62 kreuzer = 0.093 m. sterling.

- Space for the Exhibition.............................................. 44,814
  of which the floor took........................................... 64,562
   the tables......................................................... 90,873
   the passages..................................................... 119,588
  the walls or sides took.......................................... 45,927

The average space allotted to each exhibitor (taking the number of exhibitors at 6,800) was calculated at about 18 square feet of flooring and tables, and 7 square feet vertically, making in the whole somewhat more than 26 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 cost of the building is stated to have been 180,000 florins, or about 88,000l. sterling.1

Appointments, &c.—Mr. John Whitehead, F.S.A., F. R. Inst. B.A. has been elected by the Justices of Kent, District Surveyor of the County. The following are also appointed: 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 Westminster, 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 Run- corn 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 facing the river is completed, and ready for the reception of ten 38-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 moat. On one side of the arched entrance are a series of apartments, to be used as quarters for the officers and men, a school-room, magazines, &c. These buildings are protected by a roof of great strength, covered with Sypezel's asphalt, and made bomb-proof. The battery is capable of defending itself in every direction, and of mounting guns on all sides. It is capable of holding a garrison of 500 men, and, as a protection against privates, 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, Asso. Inst. C.E.

*Paper read at the Institution of Civil Engineers.*

This Drainage of Towns is so comprehensive a subject, that its full and complete treatment, within the limit of a communication to be read over a deep ditch or artificial moat. On one side of the arched entrance are a series of apartments, to be used as quarters for the officers and men, a school-room, magazines, &c. These buildings are protected by a roof of great strength, covered with Sypezel's asphalt, and made bomb-proof. The battery is capable of defending itself in every direction, and of mounting guns on all sides. It is capable of holding a garrison of 500 men, and, as a protection against privates, 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 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 streets of Sydney, and parts of the famous of the name 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 civilization is dependent upon a correct appreciation of its merits; as the healthy existence of town populations must ever be influenced by their sanitary condition. Misery, pestilence, vice, and crime find a forcing-bed in the unsewered parts of towns, and amidst the foul air of unbridled 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 assertions.

The tendency of modern civilization 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 6,612,959 souls. In 1851, in the 79 districts, the number was 7,766,985, being an increase of 1,152,924 in ten years. When it is remembered that the greater portion of the area thus populated is comparatively low and flat, such as in the ports, and the banks of inland waters being provided for mountings, it is not surprising that this crowding should produce diseases, as is proved by the almost constant present 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,

whether in cities, 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 that portion of the subject belongs more appropriately 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. Indeed, in town the average number of deaths in the most unhealthy parts of a town are from 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 persons die annually in the worst part of it, 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 among the better-regulated parts, 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, insanitary, subject to inundations, and to the incursions of cholera, present many of the circumstances in which a deplorable race of race is inevitable. In the dense districts of Lancashire, which have been the scene of so many severe epidemics and the circumstances are often so prejudicial to their offspring, that the coming generationfive, 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 stunted stature and reduced energies. In such circumstances—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, to a great extent, dependent upon its sanitary condition. 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 contribution; it is it will be able to do so, as to study precedent, to learn from experience, and so corrected from prejudice, 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 certain things, namely, the utmost care in the execution of the practice. In one piece a brick sewer 5 feet high by 3 feet wide will be constructed at about 2s. 10s. per lineal yard, whilst in a similar situation there will be laid down an earthenware tube 1 ft. 3 in. diameter, as cheap as 10s. or 1s. per lineal yard. It must be positively wrong in such discrepancy of practice as this, and the second, the truth is discovered and proclaimed the better it will be for all parties. If that man is a benefactor to his race who makes two blades of wheat grow where one grew before, he is a benefactor; but he who constructs two lineal yards of effective sewer for the price that has 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 by the convulsions of earthquakes than by earthquakes. 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 impede the current; and wherever they are constructed, and should be formed, as the refuse will then be concentrated, either for natural removal or for agricultural use.

The outlet of sewers must be fixed by the number of houses to be drained, and the extent of the place to which they stand. The site to be drained may consist of flat alluvial land, impervious mud, or pervious gravel swingle; 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 inspected by large systems of sluices open and shut as required. 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 it may be a low-lying form of country, where a number of rivers merge 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 men skilled in the art of drainage 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. It is not possible to remove 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 suburban land previous to entering the town 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 intermittently, and therefore leaving the refuse for a time stagnant in its channels of conveyance. There are no safe and cheap means of disposing of the high-tide, land floods, or both combined, over a considerable depth of water 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. The present question is not one of 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, Cumberland, and other counties, with large areas of agricultural land only worth from one hundred to two hundred pounds per acre, are drained either by intermittents drainage or to a great extent by pumping-machines, designed and erected under the direction of the masters 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.

The sewer is either a flatly and partially rising ground sloping towards the level or low portion, the formation of intersecting 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 trouble. These must be:

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 impede the current; and wherever they are constructed, and should be formed, as the refuse will then be concentrated, either for natural removal or for agricultural use.

The outlet of sewers must be fixed by the number of houses to be drained, and the extent of the place to which they stand. The site to be drained may consist of flat alluvial land, impervious mud, or pervious gravel swingle; 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 inspected by large systems of sluices open and shut as required. 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 it may be a low-lying form of country, where a number of rivers merge 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 men skilled in the art of drainage 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. It is not possible to remove 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 suburban land previous to entering the town 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 intermittently, and therefore leaving the refuse for a time stagnant in its channels of conveyance. There are no safe and cheap means of disposing of the high-tide, land floods, or both combined, over a considerable depth of water 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. The present question is not one of 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, Cumberland, and other counties, with large areas of agricultural land only worth from one hundred to two hundred pounds per acre, are drained either by intermittents drainage or to a great extent by pumping-machines, designed and erected under the direction of the masters 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.

The sewer is either a flatly and partially rising ground sloping towards the level or low portion, the formation of intersecting 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 trouble. These must be:
cut 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, rubbish, etc. This deposit will be removed from the lateral seepage 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 constitutes the dirtiest 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 on the basis of the flood-water of an exceptional 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 18th of July 1845, there fell 1 942 inches of rain in little more than half an hour. This was equivalent to 9091 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 equates in amount 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 promise 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.

It is sought 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 the details 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 are the surfaces 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. In what proportion to contagious sewers have enough to pass the whole volume of a maximum rain-fall at such a level as shall not immolate the cellars with back-water?
5. What additional length of outlet will be involved to secure the fall and deep-laid sewers?

These are all questions of the utmost importance, involving economy and efficiency, and there are other minor questions which an engineer should settle before finally deciding on a system of town drainage.

There are also 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 fix the dimensions, 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 do not look for a special 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 water, and that the addition of size is of no use, what dimensions should town sewers be constructed? This may be partially answered by considering the principal intention in constructing town sewers.

In the case 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 materials will be readily obtainable.

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 cellars. This is for an obvious reason. The cellars were intended for an accumulation of refuse, and the failure, and failure to effect these objects, is obvious. In this metropolis, where the practice of water-closet drainage has prevailed for some time; but few even of the metropolitian 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. The public indiscriminately pour their offal down the的内容 of the streets, and the storm water 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 act of the constable of St. George's Hall was obliged to serve for the contents of large collections, and every time a drain was to receive the contents of the water-closets proposed to be erected in that building.

Here, 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 their dimensions, and the materials of which, under ordinary circumstances, they are likely to be made. The nature of the subsoil must first be well ascertained, before either the form or the material can 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 inverted, 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 proper position to this discussion. Beyond all discussion, the modern ten thousand 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 see 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, 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 have 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 3 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 3 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, having been used, have been adopted. The 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, and their sectional dimensions must be adapted accordingly. It will probably be equally 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.

The theory of pipe-sewers has been recently much agitated, and without the 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.

Street drains have been effectively-sewered, and houses efficiently drained, by earthenware pipes, where no other material 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 not attempt to pass a line, beyond which the safety of the system is serious 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 beacon.
Various forms and modes of joining earth-cement pipe sewers have been tried; there are plain ends or "butt-joints," rebate-joints—full-size, half-size or split—plugs, and the like. 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. Those pipes range from 4 inches to 30 in height and are laid with the narrow side down. In two 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 cause was easily discovered; indeed at Manchester, the pipe sewer system has proved so successful, as to be called upon by the report of the town council it is stated, "The economy effected by the use of tubular sewers is palpable, and the result will, no doubt, a great extension of the practice of draining and consequent improvement of the town." 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 joints. Plain 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 those 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 cutting, bedding, and lining pipes increases proportionately as the squares of the diameters. If large pipes are moulded too thin the finished sewer is liable to be crushed, and if the material of extraneous 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 main. 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 now be made of bricks 4½ inches thick on the bed; 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, 3 feet in diameter is cheaper than one of pottery 80 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 peculiarly suitable bricks, or by wrapping the outside of the brick with asphalt. It is difficult to arrange perfect side junctions in brick sewers, as every joint should curve in the direction of the sewage flow; but pottery junctions may be worked into the brick sewers or in some cases cast in the same mix.

In a system of sewers and drains, man-holes, at intervals will be of great service. These may be simple shafts of brickwork 3 ft. 6 in. or 3 feet in diameter, carried up over the line of sewer; or 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 hedges are generally trapped, and there is a receptacle for the heavy deposits of the sewers. Here again local contingencies will affect the application of rules. Small towns with paved streets where there is little sewer and a good fall for the sewer, need not have any elaborate gutters; a good rain gutter or a wide drain will account for the water; or into a well, or receptacle for the grate, out of which a plain bent grate passes to the sewer, which latter will be all the gully arrangement required. Gullies should be tolerably fine, that is, the spouts should not exceed 4 inches, if they are less and 6 in., if the grate is fine bored out of the solid stone. Messrs. Dollan have since made a potter's pipe, which must supersede the use of stone.

In most instances when this pipe 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 possible. At the change of direction or of gradient, there is a manhole, or half-hole, to allow of examination, or take in the sewer, but through a sewer 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 are also found, and should not 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 expensive, and the present expense of traps impedes 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 sewerage is to be apprehended, it must be provided for. Ventilating shafts must be in the streets, and should be of sufficient size and height to 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.

Sewers for various districts and purposes. The rules given for sewers 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 slinge 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 generality. Certain rules may, however, be given for town drainage:—Sewers should be below the level of cellars, and they should be adapted to the special work they have to perform. Rivers, brooks, and natural streams should not be made a part of a system of sewers, and the rivers themselves, in low districts, should be capable of resisting internal pressure.

Wherever it is practicable, the sewerage 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; openings into the ground should be limited, and water at the rate of one inch in 6 feet through the grate, should be the maximum. No circular drains should be laid, and the grate should be of the best quality, and 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 or provided with adequate sewers, unless it is free of cesspools. Cesspools, or manure tanks, at or near an outlet, are nevertheless admirable; care being taken that such outlet or delivery of the sewage refuse is not blocked or impeded, and that there is no in-draft or back draft. The true purpose of town sewerage 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 carried away in sewage or water. The more fully this is accomplished, the greater 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 which had been pointed out would be as once again in force. 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 earth-cement pipes were used. He alluded to the town of Hitchin, where, in the course of 60,000 feet of pipe sewers, from 20 inches down to 4 inches diameter, and 2 ft. 6 in. long, had each been laid for use in forty months with perfect success; the average depth below the surface of the sewers being 3 feet or more, and the smallest section was 5000 square 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 occupied, and the least liable to be subject to the pressure of urban and suburban drainage. He admitted that some of the pipes laid }
to a pumping-engine had been broken from being laid in bad ground, but after being relaid in wooden boughs 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 2 1/2 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 8 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 untenable, 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 amenity 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,
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 cleaned, 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 lamp-hole-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 HAWLISON, 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 30th April, 1854, that I should meet the Board in Swansea on Thursday, 24th 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 utmost.

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 areas 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. A visit of my visit there were numerous tadpoles; at all times there will be frogs and animals.

The question of water supply has been tolerably fully discussed by Mr. Scott, in his report of 1853. I have looked over that report, but consider it quite unnecessary to repeat published evidence 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 have seen a new 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 earthwork 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 connection with the old plant, the state of the pipes and its outfall should be determined. 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, at present, in Swansea, the operation requires both time and money, and should be 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 imputid expenditure of money on works which are not as comprehensive and expensive 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 of supply in moderate distance; and several were named. I was informed that an Act of Parliament had been obtained to take water from Cwmgelly; and also that the river Lian had been proposed, and other minor streams in the district. Mr. Strick and Mr. Glasbrook also named the river Clydach. On the 27th and 28th of April I went, in company with the mayor, Mr. Strick, and Mr. Glasbrook, and examined all the wells, the river Lian, 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 is 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 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 Lian 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. Islwyn, 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, 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 a 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 constructed and carefully conducted, would meet 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 the 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:

<table>
<thead>
<tr>
<th>River Clydach</th>
<th>2° 6' degrees of hardness.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring in the valley of the Clydach</td>
<td>1' 9' do. do.</td>
</tr>
<tr>
<td>Do. do. do.</td>
<td>3' 0' do. do.</td>
</tr>
</tbody>
</table>

or an average of 2' 6' degrees of hardness.

| River Lian | 4' 4' degrees of hardness. |
| Glanbran Brook | 2' 1' do. do. |
| Birchgrove Brook | 2' 1' do. do. |
| Gelly Brook | 2' 3' do. do. |

The river Lian, 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 Glanbran was least palatable.

The following table gives the quantitative analysis of the Clydach waters:

| Sulphate of lime | 1' 0' 0' 4' 5' |
| Carbonate of magnesia | 0' 2' 1' 3' |
| Sulphate of potash | 0' 0' 1' 3' |
| Sulphate of soda | 0' 3' 1' 1' |
| Chloride of sodium | 0' 1' 3' |
| Silica | 0' 0' 0' 0' 1' 2' 12' |

| Organic matter | 3' 0' 0' 3' |

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 poorest 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 should be to maintain 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.

One hundred and sixty miles 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 position, is not likely to accumulate, 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 that the greatest, consists in the district being bounded 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 evident 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 hundred and sixty ounces of soap are said to be saved 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 6d. per lb. represents £3.6s. The Clydach water has an average hardness of 26. 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 1l. 13s. per day for every degree of hardness above 26, or an annual cost of 602l. 5s. Five degrees in excess of 26, will therefore cost 3011l. 5s. per annum more than Clydach water, for soap alone.

**Proposed Works of Water Supply.**—Sketch of works necessary to supply 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, containing 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 feature 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. Break 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 Glangrwaen, Birchgrove, and Gelli brooks must be supplied, 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 districts.

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 atrophy 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 carry out the works to their full extent, 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 £1 per lineal yard. This would make the cost of such a main about 6000l. The necessary works on the Clydach for collecting springs, &c., need not cost more than 4000l., making in the whole, for collecting the water and conveying it to Swansea, 10,000l.

Service reservoirs, service mains, sub-mains, and branches, within the town, will not cost more than 15s. per head, making, for a population of 30,000, a sum of 32,000l. Add for land, compensation, engineering, incidental expenses, and other contingencies, 10,000l., and the estimate will be as under:—

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Works on the Clydach</td>
<td>£4,000</td>
</tr>
<tr>
<td>Aqueduct main to Clydach</td>
<td>£6,000</td>
</tr>
<tr>
<td>Plant within the town, service reservoirs</td>
<td>£3,500</td>
</tr>
<tr>
<td>Compensation, land, engineering,</td>
<td>£2,500</td>
</tr>
<tr>
<td>incidental expenses and contingencies</td>
<td>£10,000</td>
</tr>
</tbody>
</table>

**Total**                                    | £42,000| 0 0 |

I find Mr. Scott estimates the cost of waterworks, for an increased population of 55,000 as under:—

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Works on the Western district</td>
<td>£59,000</td>
</tr>
<tr>
<td>Works on the Clydach</td>
<td>£55,000</td>
</tr>
</tbody>
</table>
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, with 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 detail, works of sewerage, complete, for a similar population (30,000), and I consider that a sum of 25,000, will most completely sewer and drain the borough of Swansea.

**Springs Gauged in the Clydach Valley—**

<table>
<thead>
<tr>
<th>Spring</th>
<th>Gallons in 24 hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>White well, Clydach</td>
<td>about 45,000</td>
</tr>
<tr>
<td>Cefn Fach spring</td>
<td>about 40,000</td>
</tr>
<tr>
<td>Ffynnon Las spring</td>
<td>about 35,000</td>
</tr>
<tr>
<td>Two small springs</td>
<td>about 40,000</td>
</tr>
<tr>
<td>A third small spring</td>
<td>about 10,000</td>
</tr>
</tbody>
</table>

or a total of 170,000

These, as Mr. Strick and Mr. Glassbrook 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 HAWLISON, 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 thence a branch pipe 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 Cwmandokin reservoir, giving all the additional pressure obtained from the latter site.

The service pipes within the town have been examined. They are sound, but deficient in materials and in size. The service pipes are of cast-iron and asbestos. A portion of the present cast-iron pipes may be cleared out, and the pressure from the Cwmandokin reservoir will render the pipes more serviceable, by quickening the flow. The street mains will, I believe, bear the additional pressure. House service pipes, 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 materials and labour.

**Cwmandokin 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 25,000 or 30,000 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 Cwmandokin 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 pipe as may be required), will be laid along the new road, to Masei-street and Cradock-street. This main will also supply the houses and Brunswicks 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 casing to protect them.

New fire cocks or hydrants are required. These, with the water from Cwmandokin 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 Cwmandokin 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 an immediate rental far more than equivalent to the outlay.

The whole of the works proposed below the Cwmandokin 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:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cwmandokin reservoir to be made</td>
<td>£200</td>
</tr>
<tr>
<td>water-tight, say</td>
<td></td>
</tr>
<tr>
<td>Covering in Cwmandokin stream</td>
<td>£60</td>
</tr>
<tr>
<td>Diversion of Carn Glas stream</td>
<td>£375</td>
</tr>
<tr>
<td>Diversion of Fyne stream, &amp;c.</td>
<td>£150</td>
</tr>
<tr>
<td>Providing and laying new mains to</td>
<td>£700</td>
</tr>
<tr>
<td>town</td>
<td></td>
</tr>
<tr>
<td>Putting casings on old valves</td>
<td>£35</td>
</tr>
<tr>
<td>New hydrants or fire cocks</td>
<td>£160</td>
</tr>
<tr>
<td>Fixing ditto ditto</td>
<td>£50</td>
</tr>
<tr>
<td>Stand-pipes and hose</td>
<td>£50</td>
</tr>
<tr>
<td>Altering old mains, cleansing ditto</td>
<td>£160</td>
</tr>
<tr>
<td>New mains in side streets</td>
<td>£300</td>
</tr>
<tr>
<td>Contingencies</td>
<td>£90</td>
</tr>
</tbody>
</table>

Total: £4000

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 Cwmandokin and Bryn Mill reservoirs.

The present minimum volume of water supplied by the old works is 120,000 gallons per day. The Cwmandokin 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 Myssyd 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:

<table>
<thead>
<tr>
<th>Description</th>
<th>Estimated Cost (in £)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1230 Linear yards of main sewer.</td>
<td>£300</td>
</tr>
<tr>
<td>15 Manholes and covers</td>
<td></td>
</tr>
<tr>
<td>28 Street gullies</td>
<td></td>
</tr>
<tr>
<td>1 Tidal cast-iron outlet, with</td>
<td></td>
</tr>
<tr>
<td>flap, &amp;c., complete</td>
<td></td>
</tr>
<tr>
<td><strong>Estimated cost, £300</strong></td>
<td></td>
</tr>
</tbody>
</table>

Town Ditch and Myssyd Fields district:

<table>
<thead>
<tr>
<th>Description</th>
<th>Estimated Cost (in £)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2880 Linear yards of main sewers</td>
<td>£200</td>
</tr>
<tr>
<td>30 Manholes and covers</td>
<td></td>
</tr>
<tr>
<td>50 Street gullies</td>
<td></td>
</tr>
<tr>
<td><strong>Estimated cost, £2000</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Summary:**

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waterworks</td>
<td>4000</td>
</tr>
<tr>
<td>Sewerage of Myssyd Fields district</td>
<td>2000</td>
</tr>
<tr>
<td>Sewerage east side of river</td>
<td>600</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>£6600</td>
</tr>
</tbody>
</table>

It is proposed to expand 4000£, in improving the water-works; this, at 5 per cent, represents 200£ per annum: for depreciation, and to provide a sinking fund to repay the principal in thirty years, say 100£ additional. The annual charge will thus be 300£; and the probable income may be stated as—

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500 Houses, at 10£ each per annum</td>
<td>7500</td>
</tr>
<tr>
<td>Trade purposes</td>
<td>150</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>£8000</td>
</tr>
</tbody>
</table>

Deduct Annual charge for interest and depreciation 300£ 0 0

**Clear gain**.............. £8000 0 0

In addition to which the principal, or proposed outlay of 4000£, 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 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 corrosion from cast iron boxes beneath the feet of horses. There are no fire cocks on the mains which could be used; neither are there any wash-out valves. The cost of these improvements and additions is included in the estimate given.

Westminster, Nov. 4, 1854.

Robert Rawlinson, C.E.

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 a water wheel. 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, the divided metal or shot finally falling into the water-receiver at the base. The advantages of this over the ordinary method of casting shot alone and new 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 purchasing 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 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 velocity is equalled by the blast, so equally to support it, that no loss is sustained by bursting, and each dropping made varies but in a small proportion from the size 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.)

This 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 this 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 few 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 is mounted on the long-columns, and is placed 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 will rival 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. Petro, Brasey, 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 Prince's Bridge, and several more were being constructed. The cost of the whole was 500£, 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 completed in Canada; and it is estimated would not exceed a total cost of 650£, 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 25 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 3-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 shaft, through a spur-wheel, placed upon the cam-shaft of the 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 J, at the extremity of the driving-shaft furthest from the boiler. The middle one of the three handles H, G, moves 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 hinged travelling-crane. The driving-shaft is connected by spur gears 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-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.
STEAM TRAVELLING CRANE.

Fig. 1. Side Elevation.

Fig. 2. Plan.
WATER SUPPLY OF BIRMINGHAM.

Report of Thomas Clark, C.E., to the Public World Committee.

Having on the 30th of August last been favoured with a copy of a resolution passed by your Board, directing Mr. Pigott Smith 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 18th of the same month, soliciting you to favour me with your estimate of the probable quantity of water you deemed it necessary to obtain. That 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. Dalley. That land,rendezvous 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 116,300 gallons of water per day of twenty-four hours, and of a quality most unquestionable, as the chemical analysis to which it has been submitted, and to which I shall hereafter have occasion to refer, 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.

That the boring plan was 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 shores 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 stymed with 14 inches brickwork laid in Roman cement.
II. WATER FROM THE BIRMINGHAM WATERWORKS.—The imperial gallon leaves 37-2 grains of solid matter, or 1 in 1811. The hardness of this water is between 24" and 35’.

III. WATER FROM THE PARK-STREET PUMP.—The imperial gallon of this water leaves 159-2 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 488° 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 chlorite, carbonic acid, sulphuric acid, and nitric acid.

The saliva derived from the above constituents appear to exist in the respective waters as follows:

<table>
<thead>
<tr>
<th>Substance</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloride of sodium</td>
<td>34 grains in the water of the Boring</td>
</tr>
<tr>
<td>Sulphate of soda</td>
<td>37-2 grains in the Water works, equal to 1 in 2181.</td>
</tr>
<tr>
<td>Sulphate of potassa</td>
<td>159-2 grains in the Park-street pump, equal to 1 in 488.</td>
</tr>
<tr>
<td>Nitrate of lime</td>
<td>Traces of magnesia</td>
</tr>
<tr>
<td>Carbonate of lime</td>
<td>Traces of potassa</td>
</tr>
<tr>
<td>Traces of oxides of iron</td>
<td>Traces of oxides of iron</td>
</tr>
<tr>
<td>Traces of silica</td>
<td>Traces of organic matter</td>
</tr>
</tbody>
</table>
| Traces of phosphoric acid | The quantity of chloride of sodium (common salt), contained in a gallon of water of the experimental boriing, is 7-60 grains; that of the Birmingham waters, 4-26 grains; and in water from the Park-street pump, 8-56. The quantity of sulphide of lime in the same water is, for the boriing, 8-52 grains; for the water works, 2-98 grains; and for the Park-street well, 40-48 grains; in this latter water also, the proportion of nitrate of lime is very large; the same salt is contained, though in smaller relative proportions in both of the other waters. 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 18, 1852.

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 27,500l. Say twenty-seven thousand five hundred pounds.

THOMAS CLARK.

4, Furnivall's Inn, Holborn, Nov. 15, 1852.

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 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 is, in fact, in a situation which demands 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 equalise 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 must be raised to a sufficient elevation; 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, a careful analysis 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.—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 either 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 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 gyppum 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 boring, and many miles of boring, and many miles of boring, and many miles of boring. The quantity of sandstone that can be 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 year the corporation of Wolverhampton have already commenced a reservoir to call in some engineer, to advise as to the water works, &c.

Artisan 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. (as generally only for curing 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 Pen- dioton 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 road. The water furnished by the shafts 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 cast-iron cistern.

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 similar to Birmingham), 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 Colehill, is about 40.50 so. feet below a level at Birmingham, and allowing 4 feet for a 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:

<table>
<thead>
<tr>
<th>Probable Depths of Wells if Sunk in or near Birmingham.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assumed depths</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>300</td>
</tr>
</tbody>
</table>

Total lift required ........................................ 540 640 740 840

Known Lift of Water, if taken from or near Blythe Mills.

Lift from proposed pumping station into fountain reservoir:

------|-------|-------|-------|
60    | 60    | 60    | 60    |

Company's lift added ........................................ 240

Total lift required ........................................ 880

Or a saving of 210 feet, should the shallowest wells indicated be found sufficient, but a saving of 510 feet lift should be the deepest well 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£, 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 Aln, together with their tributaries within a circuit of 106 miles east and south of Birmingham, bounded by the following places:—Erdington, Sutton, Coldfield, Tamworth, Biddulph, Barbridge, Uttoxeter, Buxley, Fillongley, Meriden, Berkswell, Kenilworth, Stoneleigh, Warwick, Barford, Wellesbourne, Stratford-on-Avon, Wootton Wawen, Henley-in-Arden, Tanworth, and Moseley, comprising an area of 450 square miles, or 288,000 acres. We propose, for the supply of the entire 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 94 miles from the centre of Birmingham, and about 80 feet below the pumping station of the present company. This distance will be sufficient to convey the water in a single aqueduct, and the water shed of the Cole and Blythe, with their tributaries, is about 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 then low, but it is well adapted and supplies the needs of Birmingham. On examining the rivers Blythe and Cole, as also their tributaries, we found the water-saturated 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 94 miles from Birmingham and may be pumped from within a few yards of the spot to which it is again raised by gravity, being 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 693 feet, or 192 feet above that required for the Blythe and Cole. 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 Blythe are taken.—About one hundred and five square miles, ninety-two thousand standard 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 engaged on in the district, nor is there one town larger than Colehill.

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 under-shot water-wheels, both of which are available for the new supply; both of which 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 10th, 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 Colehill, which is about one mile distant; and that from this reservoir an aqueduct main be laid up the valley of the Tame, and along the pumping engine-house of the Birmingham Waterworks Company. The Birmingham and Derby line of railway from Colehill 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 in:—1. The large area at command, upwards of ninety thousand acres, and the abundant supply of water in the driest seasons. 2. The favourable charac-

* See Journal, ante p. 884.

† The drainage area of Liverpool is about 11,700 acres, for Manchester 37,000 acre; out of these acres one third of the water stored is given as compensation.
ject 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 comparatively light lift required (about 330 feet), as also the favourable gradient afforded by the valley for an aqueduct main.

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. Engine power to the extent of 300-horse power will be required. Three engines—two working, and one in reserve.

Remarks.—We beg to apologize for the brief character of our report. These 30, however, which are indispensable, do not entail any further 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.

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 as long in appearance, but 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 tell you 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. 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 taste of the water 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 ever nauseous. To compare this with Manchester, 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 got only 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 complain of, except in the worst cases, now no longer existing, when the amount rose to 34. Liverpool is being supplied with water nearly as soft and pure as that of Manchester; many other towns have followed, or are about to follow their example. To perpetrate 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: 2.663 grs.
- Inorganic matter, soluble: 15.4 grs.
- Inorganic matter, insoluble: 9.8 grs.

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 Greenbridge.

All these places send their sewage 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 not enough known what sewage water contains; water in which it is dissolved 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.

Also, 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 the matter has no such change, 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 town and country land 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 dreadfully crowded in the Tame valley, and even in the time of the flood, the Tame 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 coal pits which cover the district from one end to the other in perfectly marvellous numbers. Water from coal pits 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 houses, and the general blackness of rain water, however collected, in manufacturing districts; besides its blackness, we know that its taste unites 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 unfit 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 have 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. Surr.
# Estimate for Lighthouse and Beacon on New South Shoal, Off Nantucket, U.S.

## Syllabus of Estimate for the erection of a Pneumatic Iron Pile Lighthouse on New (Dart's) South Shoal, off Nantucket, Massachusetts. Time, four and a half years.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of structure: materials and labour</td>
<td>$39,175.50</td>
</tr>
<tr>
<td>Cost of freight</td>
<td>$1,619.00</td>
</tr>
<tr>
<td>Expenses at foundry, offices, &amp;c.</td>
<td>$16,195.00</td>
</tr>
<tr>
<td>Expenses of building up and taking down structure at foundry</td>
<td>$7,017.50</td>
</tr>
<tr>
<td>Cost of removal of tongs and mauls</td>
<td>$56,000.00</td>
</tr>
<tr>
<td>Cost of pneumatic apparatus, including steam air-pump</td>
<td>$4,084.74</td>
</tr>
<tr>
<td>Expenses of receiving-steamer first season at the shoal</td>
<td>$10,816.20</td>
</tr>
<tr>
<td>Do. second season.</td>
<td>$10,941.20</td>
</tr>
<tr>
<td>Do. third season.</td>
<td>$12,191.20</td>
</tr>
<tr>
<td>Expenses of tender-steamer first season at the shoal</td>
<td>$6,020.85</td>
</tr>
<tr>
<td>Do. second season.</td>
<td>$6,965.85</td>
</tr>
<tr>
<td>Do. third season.</td>
<td>$7,745.85</td>
</tr>
<tr>
<td>Expenses of workmen, &amp;c., first season at the shoal</td>
<td>$10,519.85</td>
</tr>
<tr>
<td>Do. second season.</td>
<td>$10,519.85</td>
</tr>
<tr>
<td>Do. third season.</td>
<td>$9,683.75</td>
</tr>
<tr>
<td>Miscellaneous expenses of construction</td>
<td>$6,952.75</td>
</tr>
<tr>
<td>Miscellaneous expenses of dwelling</td>
<td>$6,952.75</td>
</tr>
<tr>
<td>Cost of semicircular lighting apparatus</td>
<td>$6,560.00</td>
</tr>
<tr>
<td><strong>Total amount</strong></td>
<td>$322,768.78</td>
</tr>
</tbody>
</table>

Contingencies 15 per cent. $49,192.09

**Total amount** $371,960.87

Required for first year and a-half at the foundry, &c., $180,589.20

Do...for first year at the shoal (a) $40,947.70

Do...for second year...do... (p) $77,959.07

Do...for third year...do... (q) $54,000.75

**Total amount** $322,768.78

---

(a.) *Synopsis of estimate.—Materials and labour for lower or foundation section (common to beacon).*

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of wrought iron (p)</td>
<td>$13,872.65</td>
</tr>
<tr>
<td>Cost of cast-iron (a)</td>
<td>$4,515.79</td>
</tr>
<tr>
<td><strong>Total amount</strong></td>
<td>$21,484.44</td>
</tr>
</tbody>
</table>

Labor on wrought iron (g) $1,725.90

Labor on cast iron (a) $275.00

**Total amount** $21,049.90

Second (double) section (common to beacon).

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of wrought iron (p)</td>
<td>$18,044.83</td>
</tr>
<tr>
<td>Cost of cast iron (a)</td>
<td>$1,843.90</td>
</tr>
<tr>
<td><strong>Total amount</strong></td>
<td>$19,887.73</td>
</tr>
</tbody>
</table>

Labor on wrought iron (g) $3,834.90

Labor on cast iron (a) $403.00

**Total amount** $4,438.90

Third (double) section (common to beacon).

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of wrought iron (p)</td>
<td>$2,901.08</td>
</tr>
<tr>
<td>Cost of cast iron (a)</td>
<td>$158.72</td>
</tr>
<tr>
<td><strong>Total amount</strong></td>
<td>$3,059.80</td>
</tr>
</tbody>
</table>

Labor on wrought iron (g) $1,474.90

Labor on cast iron (a) $132.00

**Total amount** $1,616.90

Fourth (double) section.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of wrought iron (p)</td>
<td>$1,606.90</td>
</tr>
<tr>
<td>Cost of cast iron (a)</td>
<td>$795.00</td>
</tr>
<tr>
<td><strong>Total amount</strong></td>
<td>$2,401.90</td>
</tr>
</tbody>
</table>

Labor on wrought iron (g) $1,534.68

Labor on cast iron (a) $600.00

**Total amount** $1,934.60

House, &c., third (double) section inclusive.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of wrought iron (q)</td>
<td>$1,689.54</td>
</tr>
<tr>
<td>Cost of cast iron (a)</td>
<td>$904.61</td>
</tr>
<tr>
<td><strong>Total amount</strong></td>
<td>$2,594.15</td>
</tr>
</tbody>
</table>

Labor on wrought iron (g) $1,250.50

Labor on cast iron (a) $405.00

**Total amount** $1,655.50

---

(b.) *Current expenses of receiving steamer, &c., first, second, and third seasons at the shoal.*

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>First mate, 6 months at $100 per month</td>
<td>$600.00</td>
</tr>
<tr>
<td>Second mate, 6 months at $100 per month</td>
<td>$600.00</td>
</tr>
<tr>
<td>First engineer, 6 months at $90 per month</td>
<td>$540.00</td>
</tr>
<tr>
<td>Second man, 6 months at $65 per month</td>
<td>$390.00</td>
</tr>
<tr>
<td>Chief cook, 6 months at $70 per month</td>
<td>$420.00</td>
</tr>
<tr>
<td>First bosun, 6 months at $70 per month</td>
<td>$420.00</td>
</tr>
<tr>
<td>Second bosun, 6 months at $50 per month</td>
<td>$300.00</td>
</tr>
<tr>
<td>Steward, 1 cook, 6 months at $40 per month</td>
<td>$240.00</td>
</tr>
<tr>
<td>Substitutes of 12 persons, 183 days, at $30 per month each</td>
<td>$1,037.90</td>
</tr>
<tr>
<td>Fuel, 9 tons per day, $4.50 per ton</td>
<td>$40.50</td>
</tr>
<tr>
<td>Repairs, 34 per cent. on $18,000—cost of steamer</td>
<td>$678.00</td>
</tr>
<tr>
<td>Expenses in ordinary, 6 months, at $100</td>
<td>$600.00</td>
</tr>
<tr>
<td><strong>Total amount</strong></td>
<td>$2,616.20</td>
</tr>
</tbody>
</table>

Second season as the first

With an additional $4 per cent. for repairs $678.00

**Total amount** $3,294.20

Third season as the second

With an additional 5 per cent. for repairs $1,904.21

**Total amount** $5,200.21

---

(c.) *Current expenses of tender-steamer, &c., first, second, and third seasons at the shoal.*

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>First mate, 6 months at $75 per month</td>
<td>$450.00</td>
</tr>
<tr>
<td>Pilot, acting also as second mate, 6 months, at $60 per month</td>
<td>$210.00</td>
</tr>
<tr>
<td>First engineer, 6 months at $60 per month</td>
<td>$360.00</td>
</tr>
<tr>
<td>Second man, 6 months at $50 per month</td>
<td>$250.00</td>
</tr>
<tr>
<td>Chief cook, 6 months at $45 per month</td>
<td>$270.00</td>
</tr>
<tr>
<td>First bosun, 6 months at $45 per month</td>
<td>$270.00</td>
</tr>
<tr>
<td>Second bosun, 6 months at $35 per month</td>
<td>$210.00</td>
</tr>
<tr>
<td>Steward, 1 cook, 6 months at $30 per month</td>
<td>$180.00</td>
</tr>
<tr>
<td>Substitutes of 12 persons, 183 days, at $30 per month each</td>
<td>$1,037.90</td>
</tr>
<tr>
<td>Fuel, 14 tons per day, $12.50 per ton</td>
<td>$1,571.50</td>
</tr>
<tr>
<td>Repairs, 34 per cent. on $18,000—cost of steamer</td>
<td>$678.00</td>
</tr>
<tr>
<td>Expenses in ordinary, 6 months, at $400</td>
<td>$600.00</td>
</tr>
<tr>
<td><strong>Total amount</strong></td>
<td>$6,096.85</td>
</tr>
</tbody>
</table>

Second season as first

With an additional 5 per cent. for repairs $678.00

**Total amount** $6,774.85

Third season as second

With an additional 5 per cent. for repairs $780.00

**Total amount** $7,554.85
## Estimate for Lighthouse—Continued.

### (a)—Current expenses of workmen, etc., first or second season at the work.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superintendents of work, 133 days at $50</td>
<td>$1516</td>
</tr>
<tr>
<td>Foremen</td>
<td>$916</td>
</tr>
<tr>
<td>Machinists</td>
<td>$1288</td>
</tr>
<tr>
<td>Riggers</td>
<td>$710</td>
</tr>
<tr>
<td>Carpenters</td>
<td>$732</td>
</tr>
<tr>
<td>Blacksmiths</td>
<td>$266</td>
</tr>
<tr>
<td>Striker</td>
<td>$240</td>
</tr>
<tr>
<td>Laborers, 1 man, 6 months</td>
<td>$188</td>
</tr>
<tr>
<td>Laborers, 7 men, 2 months</td>
<td>$200</td>
</tr>
<tr>
<td>Subsistence of 26 persons, 133 days at 35 cents each</td>
<td>$1857</td>
</tr>
<tr>
<td><strong>Total amount</strong></td>
<td><strong>$10,819.55</strong></td>
</tr>
</tbody>
</table>

### Second season at the same rate as the first.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superintendents of work, 133 days at $50</td>
<td>$1516</td>
</tr>
<tr>
<td>Foremen</td>
<td>$916</td>
</tr>
<tr>
<td>Machinists</td>
<td>$1288</td>
</tr>
<tr>
<td>Riggers</td>
<td>$710</td>
</tr>
<tr>
<td>Carpenters</td>
<td>$732</td>
</tr>
<tr>
<td>Blacksmiths</td>
<td>$266</td>
</tr>
<tr>
<td>Striker</td>
<td>$240</td>
</tr>
<tr>
<td>Laborers, 6 months, 26 days</td>
<td>$250</td>
</tr>
<tr>
<td>Laborers, 1 man, 6 months</td>
<td>$188</td>
</tr>
<tr>
<td>Subsistence of 26 persons, 133 days at 35 cents each</td>
<td>$1857</td>
</tr>
<tr>
<td><strong>Total amount</strong></td>
<td><strong>$9,685.75</strong></td>
</tr>
</tbody>
</table>

### (b)—Miscellaneous expenses of construction.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freight of structure from foundry to harbour of departure and refuge</td>
<td>$1,270.65</td>
</tr>
<tr>
<td>Wharfage at harbour of departure and refuge, 3 years</td>
<td>$1,500</td>
</tr>
<tr>
<td>Temporary store-houses on wharf at harbour of departure and refuge</td>
<td>$500</td>
</tr>
<tr>
<td>Paints and paint-ole., etc., and paint-brushes, for iron work</td>
<td>$550</td>
</tr>
<tr>
<td>6 disc buoys, 500 lb. each, at $22 each</td>
<td>$1,117.60</td>
</tr>
<tr>
<td>3 disc buoys, 150 lb. each, at $17.50 each</td>
<td>$1,725</td>
</tr>
<tr>
<td>2,000 feet lumber, for scaffolding, including freight, at $4.65 per thousand</td>
<td>$9,300.85</td>
</tr>
<tr>
<td>Derrick for work at the work</td>
<td>$900</td>
</tr>
<tr>
<td>Blocks and slabs, rippling, sawing, etc.</td>
<td>$1,000.50</td>
</tr>
<tr>
<td>2 portable forges, at $250</td>
<td>$500</td>
</tr>
<tr>
<td>Blacksmith tools for forge, at $450</td>
<td>$135</td>
</tr>
<tr>
<td>Riving of iron, at $150</td>
<td>$75</td>
</tr>
<tr>
<td>500 bushels blacksmiths' coal, at 40 cents</td>
<td>$200</td>
</tr>
<tr>
<td>4 boxes, 5 of 8 ears, 3 of 6 ears, at $250</td>
<td>$2,000</td>
</tr>
<tr>
<td>Freight of derrick, blocks and slabs, forge, furnace, etc.</td>
<td>$75</td>
</tr>
<tr>
<td><strong>Total amount</strong></td>
<td><strong>$6,825.75</strong></td>
</tr>
</tbody>
</table>

### (c)—Miscellaneous expenses of dredging, etc.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 boat, 3 days, metal lifeboat</td>
<td>$500</td>
</tr>
<tr>
<td>1 dingy, metal lifeboat</td>
<td>$500</td>
</tr>
<tr>
<td>2 water-tanks, boiler-iron, $208.85</td>
<td>$208.85</td>
</tr>
<tr>
<td>6 tins oil, 9 lb each, with drip-pans, at $20.50</td>
<td>$123.50</td>
</tr>
<tr>
<td>1 fag-bell, 300 lb. at 25 cents</td>
<td>$125</td>
</tr>
<tr>
<td>Sticking machine for fag-bells</td>
<td>$525</td>
</tr>
<tr>
<td>1 cooking-room, 1 sitting-room, and 1 watching-room store for 1 man</td>
<td>$1,000</td>
</tr>
<tr>
<td>Furniture, coal, etc.</td>
<td>$300</td>
</tr>
<tr>
<td>21,000 feet finished floors, for dwelling, including freight, at $4.25 per thousand</td>
<td>$91,575</td>
</tr>
<tr>
<td>Carpenter's work on coal, coal, etc.</td>
<td>$1,000</td>
</tr>
<tr>
<td>Hardware for dwelling: locks, hinges, etc.</td>
<td>$1,000</td>
</tr>
<tr>
<td>Glass for dwelling, at $1.65 each</td>
<td>$1,300</td>
</tr>
<tr>
<td>Pans, and paint-ole., for dwelling, in rack 36 inches wide</td>
<td>$225</td>
</tr>
<tr>
<td>Toils for repairing lighting apparatus</td>
<td>$170</td>
</tr>
<tr>
<td><strong>Total amount</strong></td>
<td><strong>$6,922.87</strong></td>
</tr>
</tbody>
</table>

### (d)—Cost of lenticular lighting apparatus, etc.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lenticular lighting apparatus, let order fixed</td>
<td>$3,000</td>
</tr>
<tr>
<td>Fixtures and expenses for same</td>
<td>$300</td>
</tr>
<tr>
<td><strong>Total amount</strong></td>
<td><strong>$3,300.00</strong></td>
</tr>
</tbody>
</table>

### (e)—Expenses of first year and a half at foundry, etc.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agent at foundry</td>
<td>$1,918.00</td>
</tr>
<tr>
<td>Books, etc., on construction, stationery, office and drawing</td>
<td>$292.50</td>
</tr>
<tr>
<td>Office rent, office fuel, office attendance</td>
<td>$375</td>
</tr>
<tr>
<td>Clerk and draughtsmen</td>
<td>$9,700.00</td>
</tr>
<tr>
<td>Cost of structure—materials and labour</td>
<td>$21,075.00</td>
</tr>
<tr>
<td>Cost of patterns and model of structure</td>
<td>$1,500</td>
</tr>
<tr>
<td>Cost of pneumatic apparatus, including steam air-pump</td>
<td>$4,044.14</td>
</tr>
<tr>
<td>Expenses of building up and taking down structure at foundry</td>
<td>$7,072.60</td>
</tr>
<tr>
<td>Cost of receiving and tender-steamer and camels</td>
<td>$25,000</td>
</tr>
<tr>
<td>Freight of structure from foundry to harbour of departure and refuge</td>
<td>$1,120.00</td>
</tr>
<tr>
<td>Temporary store-houses at harbour of departure and refuge</td>
<td>$350</td>
</tr>
<tr>
<td>Quarters and fuel for 2 superintendents and 5 laborers</td>
<td>$2,500</td>
</tr>
<tr>
<td>Transportation of baggage of 3 officers U.S. Army</td>
<td>$225.00</td>
</tr>
<tr>
<td><strong>Total amount required for first year and a half at foundry, etc.</strong></td>
<td><strong>$46,594.27</strong></td>
</tr>
</tbody>
</table>

### Estimate for Beacon.

#### Synopsis of Estimate for the erection of a Pneumatic Iron Pile Beacon on New (David's) South Shoal, off Nantucket, Massachusetts. Time, three years.

- **Cost of structure: materials and labour:** $96,159.05
- **Cost of patterns:** $425.00
- **Expenses at foundry, offices, etc.:** $12,045.50
- **Expenses of building up and taking down structure at foundry:** $4,945.00
- **Cost of receiving and tender-steamer and camels:** $56,000.00
- **Cost of pneumatic apparatus, including steam air-pump:** $4,084.74
- **Expenses of receiving-steamer first season at the shoal:** $10,316.20
- **Do. do. second season do.** $10,741.20
- **Do. do. tender-steamer first season do.** $9,350.85
- **Do. do. second season do.** $10,959.85
- **Do. do. workmen, &c., first season do.** $10,519.95
- **Do. do. second season do.** $10,519.95
- **Miscellaneous expenses of construction:** $2,553.00

### Amount

- **Total amount:** $324,654.75

### Contingencies

- **16 per cent.:** $52,024.72

### Total amount

- **$272,630.03**
<table>
<thead>
<tr>
<th>Estimate for Reacon</th>
<th>Estimate for Reacon—Continued</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a.)—Materials and labour for lower or foundation section (common to light-house).</td>
<td>1 steward, 1 cook, 6 months, at $30 per month each</td>
</tr>
<tr>
<td>Cost of wrought-iron (a)</td>
<td>Subsistence of 24 persons, 183 days, at 35 cents each</td>
</tr>
<tr>
<td>Cost of cost of material</td>
<td>Fuel, 3 tons coal per day, 449 tons, at $6</td>
</tr>
<tr>
<td>Labour on wrought-iron (a)</td>
<td>Repairs, 34 per cent. on $38,000, cost of steamer</td>
</tr>
<tr>
<td>Cost of labor</td>
<td>Expenses in ordinary, 8 months, at $100</td>
</tr>
<tr>
<td>Cost of labour</td>
<td>Total amount</td>
</tr>
<tr>
<td>Second season same as the first</td>
<td>With an additional 24 per cent. for repairs</td>
</tr>
<tr>
<td></td>
<td>Total amount</td>
</tr>
<tr>
<td>(b)—Current expenses of tender-steamer, &amp;c., first and second seasons at the shoal.</td>
<td>1 master, 6 months, at $75 per month</td>
</tr>
<tr>
<td>Cost of wrought-iron (b)</td>
<td>1 mate, 6 months, at $45 per month</td>
</tr>
<tr>
<td>Cost of cost of material</td>
<td>1 pilot, acting also as master, at $60 per month</td>
</tr>
<tr>
<td>Labour on wrought-iron (b)</td>
<td>1 first engineman, 6 months, at $50 per month</td>
</tr>
<tr>
<td>Cost of labor</td>
<td>1 second do., 6 months, at $50 per month</td>
</tr>
<tr>
<td>Cost of labour</td>
<td>1 fireman, 6 months, at $30 per month</td>
</tr>
<tr>
<td>2 boatswains, 6 months, at $50 per month each</td>
<td>600 00</td>
</tr>
<tr>
<td>1 steward, 1 cook, 6 months, at $30 per month each</td>
<td>840 00</td>
</tr>
<tr>
<td>2 men, 6 months, at $50 per month each</td>
<td>100 00</td>
</tr>
<tr>
<td>8 hands, 6 months, at $75 per month each</td>
<td>720 00</td>
</tr>
<tr>
<td>Fuel, 14 tons coal per day, 2714 tons, at $6</td>
<td>1,547 00</td>
</tr>
<tr>
<td>Repairs, 34 per cent. on $15,000, cost of steamer</td>
<td>515 00</td>
</tr>
<tr>
<td>Expenses in ordinary, 8 months, at $100</td>
<td>480 00</td>
</tr>
<tr>
<td>Total amount</td>
<td>6,690 85</td>
</tr>
<tr>
<td>Second season same as first</td>
<td>With an additional 24 per cent. for repairs</td>
</tr>
<tr>
<td></td>
<td>Total amount</td>
</tr>
<tr>
<td>(c)—Current expenses of cook, &amp;c., first and second seasons at the shoal.</td>
<td>1 steward, 1 cook, 6 months, at $30 per month each</td>
</tr>
<tr>
<td>Cost of wrought-iron (c)</td>
<td>Subsistence of 17 persons, 183 days, at 35 cents each</td>
</tr>
<tr>
<td>Cost of cost of material</td>
<td>Fuel, 14 tons coal per day, 2714 tons, at $6</td>
</tr>
<tr>
<td>Labour on wrought-iron (c)</td>
<td>Repairs, 34 per cent. on $15,000, cost of steamer</td>
</tr>
<tr>
<td>Cost of labor</td>
<td>Expenses in ordinary, 8 months, at $100</td>
</tr>
<tr>
<td>Cost of labour</td>
<td>Total amount</td>
</tr>
<tr>
<td>Total amount</td>
<td>10,719 85</td>
</tr>
<tr>
<td>Second season same as the first</td>
<td>Second season at the shoal same as the first</td>
</tr>
<tr>
<td></td>
<td>Total amount</td>
</tr>
<tr>
<td>(d)—Miscellaneous expenses of construction.</td>
<td></td>
</tr>
<tr>
<td>Freight of structure from foundry to harbour of departure and refuge, 660 tons, at $1 75</td>
<td>918 00</td>
</tr>
<tr>
<td>Wharfage at harbour of departure and refuge, 2 years, at $600</td>
<td>1,000 00</td>
</tr>
<tr>
<td>Temporary wharf-house on wharf at harbour of departure and refuge</td>
<td>240 00</td>
</tr>
<tr>
<td>Paints, and paint-oils, &amp;c., and bronze brushes, for ironwork</td>
<td>280 00</td>
</tr>
<tr>
<td>2 do. disc-hoops, 60 lb. each, at $2 40 each</td>
<td>30 00</td>
</tr>
<tr>
<td>2 do. 50 lb. each, at $2 37 60</td>
<td>30 00</td>
</tr>
<tr>
<td>6000 feet lumber for scaffolding, including freight, at $2 40 per thousand</td>
<td>138 00</td>
</tr>
<tr>
<td>Derrick for the work at the shoal</td>
<td>800 00</td>
</tr>
<tr>
<td>Blocks and falls, rigging, lascings, &amp;c.</td>
<td>1,000 00</td>
</tr>
<tr>
<td>2 portable forges, at $300 each</td>
<td>70 00</td>
</tr>
<tr>
<td>Blacksmith tools for do., at $24 each</td>
<td>118 00</td>
</tr>
<tr>
<td>300 bushels of blacksalls' coal, at 36 cents each</td>
<td>60 00</td>
</tr>
<tr>
<td>2 boxes—2 of 9 ears, 2 of 6 ears</td>
<td>1,000 00</td>
</tr>
<tr>
<td>Derrick of wrought, blocks and falls, forges, &amp;c.</td>
<td>70 00</td>
</tr>
<tr>
<td>Total amount</td>
<td>5,683 00</td>
</tr>
<tr>
<td></td>
<td>Total amount</td>
</tr>
<tr>
<td>(e.)—Materials and labour for pneumatic apparatus, including steam air-pump (common to light-house).</td>
<td>Contingencies, 16 per cent.</td>
</tr>
<tr>
<td>Cost of wrought-iron</td>
<td>Total amount required for first year at foundry, &amp;c.</td>
</tr>
<tr>
<td>Cost of cost of material</td>
<td></td>
</tr>
</tbody>
</table>

THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL.

ESTIMATE FOR MATERIALS AND LABOUR—Continued.

<table>
<thead>
<tr>
<th>Material</th>
<th>Description</th>
<th>Rate per 1000 lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>371 square feet 8-16 roller-iron for walls of wash-room</td>
<td>.50</td>
<td>1.50</td>
</tr>
<tr>
<td>241 square feet 8-16 roller-iron for roof of laurcer, 3500 lbs.</td>
<td>.50</td>
<td>1.50</td>
</tr>
<tr>
<td>6,448 rivets for the above roller-iron work, 4171 lbs.</td>
<td>.50</td>
<td>1.50</td>
</tr>
<tr>
<td>8 lower floor beams of dwelling, 4 by 8-inch, 1118 lbs. at 1000 lbs.</td>
<td>.50</td>
<td>1.50</td>
</tr>
<tr>
<td>12 second-floor beams of dwelling, 4 by 8-inch, and 1 beam, 4 by 8-inch, 3612 lbs. at 600 lbs.</td>
<td>.50</td>
<td>1.50</td>
</tr>
<tr>
<td>13 third-floor beams of dwelling, 4 by 8-inch, and 1 semi-circular ring, 4 by 19-inch, 2768 lbs. at 300 lbs.</td>
<td>.50</td>
<td>1.50</td>
</tr>
<tr>
<td>16 roof beams of dwelling, 4 by 8-inch, and circular ring, 4 by 12-inch, 2618 lbs. at 300 lbs.</td>
<td>.50</td>
<td>1.50</td>
</tr>
<tr>
<td>16 bracket bars for lower gallery, 8 by 6-inch, 2714 lbs. at 300 lbs.</td>
<td>.50</td>
<td>1.50</td>
</tr>
<tr>
<td>24 wall bars of dwelling, 88 lbs. at 650 lbs.</td>
<td>.50</td>
<td>1.50</td>
</tr>
<tr>
<td>193 feet 14-inch iron for hand-rail stems of cylinder, 930 lbs. at 450 lbs.</td>
<td>.50</td>
<td>1.50</td>
</tr>
<tr>
<td>1 foot-ring outside of lantern, 164 lbs. at 45 lbs.</td>
<td>.50</td>
<td>1.50</td>
</tr>
<tr>
<td>96 oblique mash-bars of lantern, 934 lbs. at 6 lbs.</td>
<td>.50</td>
<td>1.50</td>
</tr>
<tr>
<td>1 ring and 33 horizontal mash-bars of lantern, 784 lbs. at 6 lbs.</td>
<td>.50</td>
<td>1.50</td>
</tr>
<tr>
<td>1 hand and 1 foot-ring outside of lantern, 218 lbs. at 6 lbs.</td>
<td>.50</td>
<td>1.50</td>
</tr>
<tr>
<td>96 mash-bars, 36 lbs. at 35 lbs.</td>
<td>.50</td>
<td>1.50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Labour</th>
<th>Description</th>
<th>Rate per 1000 lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>464 lbs. iron for holing apparatus for store, frame carriage, &amp;c.</td>
<td>.50</td>
<td>1.50</td>
</tr>
<tr>
<td>400 lbs. iron for gearing, common to both holing apparatus, 672 lbs. bolt and bar iron, assorted sizes, for bolts, nuts, straps, &amp;c. for sections, at 4 lbs.</td>
<td>.50</td>
<td>1.50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TOTAL</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$4,497.55</td>
<td>6</td>
</tr>
</tbody>
</table>

Estimate for patterns (b).

<table>
<thead>
<tr>
<th>Material</th>
<th>Description</th>
<th>Rate per 1000 lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 lower floor beams of dwelling, forging, chipping, boring bolt-holes, &amp;c., at $5</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>8 second-floor beams and 1 beam of dwelling, forging, chipping, boring bolt-holes, &amp;c., at $5</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>8 third-floor beams and 1 semi-circular ring of dwelling, forging, chipping, boring bolt-holes, &amp;c., at $5</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>8 roof-beams, and 1 circular ring of dwelling, forging, chipping, boring bolt-holes, &amp;c., at $5</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>24 wall bars of dwelling, forging, chipping, boring bolt-holes, &amp;c., at $5</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>198 ft. 14-in. hand-rail of iron in cylinder, bending, &amp;c., at $6</td>
<td>.50</td>
<td>6.00</td>
</tr>
<tr>
<td>1 foot-ring outside of lantern, turned, drilled, chipping, &amp;c., at $5</td>
<td>.50</td>
<td>5.00</td>
</tr>
<tr>
<td>96 oblique mash-bars of lantern, forging, chipping, boring bolt-holes, &amp;c., at $5</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>1 ring and 33 horizontal mash-bars of lantern, ring, 940 lbs., at 100 lbs.</td>
<td>.50</td>
<td>3.00</td>
</tr>
<tr>
<td>1 hand and 1 foot-ring outside of lantern, 86 lbs. bending, &amp;c., at 60 lbs.</td>
<td>.50</td>
<td>3.00</td>
</tr>
<tr>
<td>1 prisma, forging, &amp;c.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>148 lbs. bar and round iron for bolt-holding apparatus, darts, &amp;c.</td>
<td>.50</td>
<td>12.00</td>
</tr>
<tr>
<td>580 lbs. iron for holing apparatus for store, frame carriage, &amp;c.</td>
<td>.50</td>
<td>7.50</td>
</tr>
<tr>
<td>400 lbs. iron for gearing, common to both holing apparatus, 672 lbs. bolt and bar iron, assorted sizes, for bolts, nuts, straps, &amp;c. for sections, at 4 lbs.</td>
<td>.50</td>
<td>6.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TOTAL</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$2,966.00</td>
<td>6</td>
</tr>
</tbody>
</table>

Estimate for patterns (c).

<table>
<thead>
<tr>
<th>Material</th>
<th>Description</th>
<th>Rate per 1000 lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 centre hollow pipe from base of dwelling to base of wash-room, 18th fl. 1000 lbs. at $5</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>24-inch floor-plates, lower story of dwelling, dining, &amp;c., &amp;c.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>16 1-inch floor-plates, lower gallery of dwelling, 4-inch, at 600 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>32 floor-plates of lantern, 4-inch, at 600 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>4 landing-plates of lantern, 4-inch, at 600 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>14-inch floor-plates of dwelling, 5-inch, at 600 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>8 12-inch floor-plates of dwelling, 6-inch, at 300 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>24 brackets, corners of second story of dwelling, 750 lbs. at 3 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>32 brackets, corners of roof of dwelling, 774 lbs. at 4 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>4 mash-door frames, lower story of dwelling, 1442 lbs. at 6 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>2 window-frames of dwelling, 856 lbs. at 6 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>1 window and 2 mash-door frames of dwelling, 466 lbs. at 4 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>1 window in lantern, 488 lbs. at 3 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>1 door and door-frame in cylinder, top of dwelling, 415 lbs. at 6 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>1 door and door-frame in cylinder, top of dwelling, 415 lbs. at 6 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>4 dead-eye hole frames and shutters, drilling, &amp;c. at $9</td>
<td>.50</td>
<td>3.60</td>
</tr>
<tr>
<td>116 steps in cylinder, 216 lbs. at 6 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>8 registers in wash-room, drilling, chipping, &amp;c. at $5</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>6 exterior and 8 interior brackets, wash-room and lantern</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>12 base rings of lantern, 1390 lbs. at 3 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>4 floor-plates of lantern, 1658 lbs. at 3 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>8 floor-plates of lantern, drilling, &amp;c. at $5</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>1 smoke-flue of lantern, 435 lbs. at 3 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>1 base-ring, frame of lantern, 226 lbs. at 3 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>1 ventilator, &amp;c. do. do. do. do. do.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>1 cornice do. do. do. do. do.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>4 cap do. do. do. do. do.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>24 lbs. 4 boxes and 1 lamp, best holing apparatus, drilling, &amp;c.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>140 lbs. holing apparatus for store, drum, &amp;c. at 6 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
<tr>
<td>1800 lbs. gearing, common to both holing apparatus, drilling, &amp;c. at 6 lbs.</td>
<td>.50</td>
<td>4.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TOTAL</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$2,000.00</td>
<td>6</td>
</tr>
</tbody>
</table>
### THE CIVIL ENGINEER AND ARCHITECT’S JOURNAL

#### ESTIMATE FOR PATTERNS—Continued.

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facia and facade of cornice of third story of dwelling</td>
<td>$12.00</td>
</tr>
<tr>
<td>Cornice and entablature</td>
<td>70.50</td>
</tr>
<tr>
<td>Third series of alcoves or cupboards</td>
<td>22.50</td>
</tr>
<tr>
<td>Soffit-cap of pilings</td>
<td>74.25</td>
</tr>
<tr>
<td>Dead-eye lights in cylinder</td>
<td>10.00</td>
</tr>
<tr>
<td>Base ring of eastern</td>
<td>31.60</td>
</tr>
<tr>
<td>Top ring of eastern</td>
<td>26.00</td>
</tr>
<tr>
<td>Railing around watch-room</td>
<td>87.50</td>
</tr>
<tr>
<td>Gallery four-plates around watch-room</td>
<td>15.20</td>
</tr>
<tr>
<td>Pile-capital under entablature</td>
<td>15.00</td>
</tr>
<tr>
<td>Smoke-flue in eastern</td>
<td>15.60</td>
</tr>
<tr>
<td>Cap-ring in base of dome</td>
<td>15.00</td>
</tr>
<tr>
<td>Ventilators in cupola</td>
<td>15.00</td>
</tr>
<tr>
<td>Cornice in cupola</td>
<td>15.00</td>
</tr>
<tr>
<td>Cap of cupola</td>
<td>12.00</td>
</tr>
<tr>
<td>Brackets for eastern</td>
<td>9.60</td>
</tr>
<tr>
<td>Registers in watch-room</td>
<td>12.60</td>
</tr>
<tr>
<td>Brackets in entablature</td>
<td>19.00</td>
</tr>
<tr>
<td>Brackets in cornice, second story</td>
<td>17.75</td>
</tr>
<tr>
<td>Brackets in cornice, third story</td>
<td>18.60</td>
</tr>
<tr>
<td>Railing of first gallery</td>
<td>8.80</td>
</tr>
<tr>
<td>Railing of second gallery [part of first story used for this]</td>
<td>8.80</td>
</tr>
<tr>
<td>Railing of roof</td>
<td>11.50</td>
</tr>
<tr>
<td>Steps in cylinder</td>
<td>15.90</td>
</tr>
<tr>
<td>Window and door frames</td>
<td>25.90</td>
</tr>
<tr>
<td>Pocket for spider-web brushes</td>
<td>8.36</td>
</tr>
<tr>
<td>Cast-iron block</td>
<td>5.90</td>
</tr>
<tr>
<td>Gallery-plate around lantern</td>
<td>15.97</td>
</tr>
<tr>
<td>Interior plate around eastern gallery</td>
<td>15.90</td>
</tr>
<tr>
<td>Chaps for spider-web backing (four)</td>
<td>13.50</td>
</tr>
<tr>
<td>Chaps for spider-web backing (two)</td>
<td>10.50</td>
</tr>
<tr>
<td>Chaps for diagonal braces</td>
<td>10.80</td>
</tr>
<tr>
<td>Total amount</td>
<td>$129.90</td>
</tr>
</tbody>
</table>

#### Pneumatic Apparatus, common to both Light-house and Beacon

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 air-pipes (370 feet), from soil-receivers to exhausted-receivers, at 12 cents...</td>
<td>$23.40</td>
</tr>
<tr>
<td>9 straws for supporting soil-receivers, 117 lb. at 44 cents...</td>
<td>41.02</td>
</tr>
<tr>
<td>7.17 lbs. 33</td>
<td></td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumatic Apparatus, common to both Light-house and Beacon</td>
<td>$23.40</td>
</tr>
</tbody>
</table>

#### Light-box, common to Beacon

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 air-pipes (370 feet), from soil-receivers to exhausted-receivers, at 24 cents...</td>
<td>66.90</td>
</tr>
<tr>
<td>9 straws for supporting soil-receivers, 35 lbs. at 44 cents...</td>
<td>41.02</td>
</tr>
<tr>
<td>27.17 lbs. 33</td>
<td></td>
</tr>
</tbody>
</table>

#### Labour on wrought-iron

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 air-pipes (370 feet), from soil-receivers to exhausted-receivers, at 24 cents...</td>
<td>66.90</td>
</tr>
</tbody>
</table>

#### Total amount

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumatic Apparatus, common to both Light-house and Beacon</td>
<td>$23.40</td>
</tr>
</tbody>
</table>

---

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 Shoul; 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 light-house at New South Shoul.

### Office of New South Shoal Beacon,
Philadelphia, Dec 27, 1851.

HARTMAN BACHE,
Major Topographical Engineers, Brevet Major.

---

*All costs are in 1851 dollars.*

**Edystone.**—1765 to 1769 inclusive. The mean height of the rock above low water is given. Light first exhibited 10th of October, 1759.

**Bell Rock.**—1807 to 1810 inclusive. Light first exhibited 1st of February, 1811.

**Skerryvore.**—1888 to 1891 inclusive. Light first exhibited 1st of February, 1844; surveys, 1834 and 1835; opening quarts, &c., 1856 and 1837. The nearest harbour is Hythe Bay, which being open through a large bay, others about the islands of Cow 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. Naukshia 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.
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 rivers, both as regards their conduct, 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 preventing or removing 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, mole, 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 "benton" for forming foundations under water or on dry land, and for strengthening the exterior of (or inside) structures.

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 notes 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 forms of tensile, compressive, transverse, torsional, 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 triangles; 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 stays-chains.

15. The 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 overheating 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 experience and application of steam-power and steam-propellers to the propulsion 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 road, rolling stock, 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-trees, having special reference to the increased capability of resisting lateral strain and shunting.

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 axles, wheels, axles, bearings, and brakes, treating particularly their ascertainment 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 registers 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 water for steam navigation.

29. The laws governing the velocity and discharge of currents of water, whether in pipes or in open channels, receiving tributary sources 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 continuity 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 number and description of excreta, the disposal of the sewerage, 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-damaged 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 expediton is combined with the least amount of breakage of the coal, and also accounts of the means of unloading, and measuring, or weighing the coal on its arrival in port.

35. Descriptions of the forms 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 ormes (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 of the different degrees of curvature, when exposed to direct and oblique winds, with practical examples.

38. On the application of machinery combined with mechanical power, and the means of transporting merchandise and produce on large farms, and the 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 forgeable iron, and the chemical characteristics which affect the physical properties of cast or of wrought iron.

42. Description of cast or wrought iron oranes, soafolding, and machinery employed in large works, in stone quarries, holste or lift 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 best-root with regard to quantity, quality, and economy of manufacture.

44. Accounts of the improved systems of storing corn, and of produce in general.

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 manufacture.

47. Notice of the principal self-acting tools employed in the manufacture of engines and machines; also of moulding-machines and woodworking machines, and the effect of their introduction.

48. The construction of lime-kilns, 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 Mollard, Arthur Woolf, Jonathan Hornblower, Richard Trevithick, William Murdoch (of Soho), and Alexander Nimmo.
THE DISTINCTION BETWEEN ILLUMINATION AND PAINTING.

MR. RUSKIN'S LECTURE ON DECORATIVE COLOUR AT THE ARCHITECTURAL MUSEUM.

Mr. Ruskin commenced by stating that he was not going to read a paper or speak from notes, and it was a mistake in the admittance that he did not deliver 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 some points in the view of explaining the examples he proposed to set before them. In those 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 these days so much as we do now, but they wrote much better than 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 the richly died in the year 888, St. Salisbury. 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 at the same place again and again, and never doubled simply upon itself. Such was the general character of the MS. of that century. It was 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 written in, as it were, in squares, 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 when now examining; but he employed those who could, and paid great respect to them. Immense respect was paid 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 Arniesberg a writer named Richard, an Englishman, who had with his own hand copied a great number of books, hoping to receive in heaven a resuscitation for his labours. When he quitted this life, his books were wrapped up in his funeral garments. A few days after he died, 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 seal in the days of the middle ages. He 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 are indebted for our English literature—Alfred the Great. 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 reading 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 jocundity she gave 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 instance to study with our English Alfred, and he was not quite sure whether it would not be equally possible that a similar thing might happen to a child of 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" was ever, or under any circumstances become, an apple-pie.

The idea of the shape of the age of illuminated writing, 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 the sanctity. It was noble, inasmuch as it was the means of making human thought—the most transient and evanescent of all things—the most lasting and the most permanent. Thus the idea of the books, which then obtained in men's minds, they worked, and worked on, and explain 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 other ordered to form the bounds of the tabernacle, and the 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 out (exhibiting it in a Bible of the year 1280) it was but a common example, but worth exhibiting, on account of the clerical 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 time. In figures beating each other, as it were, in Dante's time, it came to be 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 best my reigns down, and one
(Not he who speaks twisted beneath the weight
That urged him, saw me, knew me straight, and call'd,
Holding his eye, it stirred not, the "I went,"
Dispersion of the air."
"O Art thou not Odeger? Art thou not
Art thou not
The glory of God's spirit, of the fire of God?
Which they of Paris call the limner's skill?
"Brother," said he, "with tints that may smile,
With tints that may flame, that may light,
That may flame, that may light,
Dante 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 "aluminam," does not mean the same 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 at the height also by the career of St. Louis, and the next example which he (the king) had executed, was the Psalter of St. Louis, a MS. prayer book of higher capacity as a work of art than a religious picture, but it was a gift to 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 received with great delight, as the story of the Saliwara—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 Pope Urban VI., 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 1232, 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 list of the less of the leaves were no gold, there could be no life. That might be taken as the great rule of the He might, while upon this point, remark, that one of the great 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 an 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 star must be graceful must not have the same legs 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 life. When of the arts he would present to their notice was a capital letter at the beginning of a psalter. 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 1300. Here, they would observe, the prevailing colours were the same, but the animal and plant introductions were much 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 was wished to bring to notice, on account of the human face introduced at the top of the page. The illuminations represented Solomon, having been named David's successor, being made to ride upon the king's own male, 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: 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 MS. now exhibited, one given to Queen Blanche, in the sixteenth century, exhibited with care, care, and care, and in a marked degree. The art having reached its culminating points 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 attempts to attain greater luxury and richness, until the art went out of fashion. The art of painting and design here illustrated, 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 more renowned sufficiently in these days—he said also that neither were painters revered in the eyes of others, and he thought it 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 time 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 much greater capacity as a work of art than a religious picture; 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 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 open to men of genius; but if a man gave up his mind to an illuminator—if he learned 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 graded pure colours, 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, that the form might be thickened on the side opposite to the light. 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 often be seen on the dark side than on the light side. Besides, the varicinity 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 practice was perfectly faithful outline, and all the other things much more could be explained 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, as some of the others, was very 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 our these more outlines in as in working out a fully shadowed drawing, like one he now exhibited (a bunch of leaves very far inferior in the 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 those who could not achieve to give a correct perspective, whatever 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 desirable to those who pursued this art now, that its effects on the street, leaving it in printing 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, the insects in the streets, leaves. In printing it, 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 his friends, praying him to give up the art of hand writing—of handwriting, 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 lived by any painter with the patience and diligence and method habituated to this art, and he would have as much pleasure in the study of illuminating as that 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 see that it was becoming again a thing to be paid for and 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

As showing the kind of life he would encourage, he would ask permission to read a passage from Longfellow, describing the Friar Pacido transcribing and illuminating the Gospel of St. John:

"It is growing dark! yet one lone cloud

And the sun's glory, for today is a day like none other. I come again to the name of the Lord. Have I forgotten how to love? That is spoken so lightly among men, let me pause awhile, and wash my pen: Pure from blasphemy, and holy and great is it.

When it that word of mercy? Thrice have I learned on earth

Nearby through the Gospel of St. John. Can it be that from the life of this gentle saint, that Christ himself perhaps has blessed, that the good Apocalypse? It has a very awful look.

As it stands before the sight of the Book. Ah! when I think of that vision divine, think of writing as is like fire.

I stand in awe of the terrible curse. Like the trumpet of doom in the closing verse. God forgot me if ever I

Take sight from the Book of Prophecy now, yet I am glad, should be taken 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 be afraid to imitate it. In open day, on the self-same shelf,

With the written and the printed word,

Or of St. Theodota, who of old

Wrote the Gospel in letters of gold! That boldness which was by the hand,

Without a single blot or blunder,

Would not bear the Labor of my hand,

If we should compare them like by like. They, now, ladies and gentlemen, King Bevis himself never made better!

Finished down to the leaf and the small

Down the eye on the preacher's desk! And now, as I turn the volume over,

And see what lines over and cover,

What treasures of art these pages hold, All alike, which cubic feet.

God forgive me! I seem to feel.

A certain satisfaction rises,

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 my work.

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 lightly a pen

To paint my landscapes and my leaves!

How the swallow twitter under the same! There, now, there is one in bloom.

I can just catch a glimpse of her head and her breast;

And will soon move in another house, and look, 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 introduced them to 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.

61
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 result, it is expected, will be similar for most of the colliery enterprises. A ton of coal costs 43 francs at Auvin, 66 francs at the mines of the Loire, 69 francs at Firminy, 66 francs at Blanzy, 63 francs at the Charbonnages Belges, 48 francs at the Grand 'Combe, 60 francs at Commentary, 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 Lanchas, where it is only 30 francs per ton.  Elling 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 ft., having open roofs of high pitch ceiled against the rafters. There is a girls' class-room 16 ft. by 18 ft., and boys' 16 ft. by 18 ft. 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 tran- soms 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 1000£. The cost of boundary fences, 250£. 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" x 18'.
B. Girls' Class Room, 18' x 18'.
C. Boys' School, 78'6" x 18'.
D. Boys' Class Room, 18' x 18'.
E. Miss's Sitting Room, 12'6" x 12'6".
F. Kitchen, 12'6" x 12'6".
G. Scullery, 8'6" x 7'0".
H. Pantry.
I. Water-closet.
The other Closets are against the east side of the Play-ground.
J. Three Bedrooms over E and F.
K. Garden.
ELECTROTYPING COPPERPLATE.

Among the specimens of miscellaneous philosophical processes of products exhibited at the New York Crystal Palace Exhibition, were a copperplating process, produced at the United States Coast Survey Office. The plates are of three in number and consist of—1, the original engraved plate; 2, a reverse or matrix obtained therefrom by electro deposit; and 3, a "duplicator" 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 the latter of course a part of 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, and founded on sound philosophical principles, whilst some of them are claimed as the invention of Mr. Mathioli, 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. When the action of the iodine has been completed (by an infinitesimal film of the deposit), without in the slightest degree impairing the sharpness of the impression, the thickness of the coating of iodine vapour being estimated by Mr. Mathioli at one forty-four millionths 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 hundred thousandth 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 9-inch thick, and 3 feet of square, can be made from 224 pounds 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, 9-inch thick, which are exhibited near these plates. One of these 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. Mathioli manufactures or produces the negative silver plates of his batteries by electro deposition, and in order to remove from their planished surfaces the impurities of the zinc plates, which are sometimes found to adhere to them themselves the plates immerse 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.

REPORT OF THE UNITED STATES COMMISSIONER OF PATENTS FOR THE YEAR 1853. PART II. 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 Examiner are omitted, on the supposition that the plainness of the language might be more usefully employed, and that it was impossible to avoid invisibly 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 flourish, 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 rightly decided by the Examiner. The examination of all classes of Examiners is therefore as much 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 insensible to the principles 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 who may pay others $200, for that which we grant to our own citizens for $80. 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 justly or more securely proved than that of the first inventor. 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 patentees 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. There is no 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 native and foreigner. 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 patent, he, even prior to his taking steps to become a citizen. If he hold 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 the case of a patent?

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 not only acquires the 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 play the role of human exchangers, 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 insatiable 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 Palace. At the canon’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 naturalized 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 rule would be just, simple, just, courteous, 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 individualizing or prejudgeting about that great brotherhood of nations for which a higher civilization is gradually preparing the world."

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 unaltered. 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 absolutely necessitates an increase of the office to discharge all the business which 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 increases 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 a row, and the muffs 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 muffs, an aperture is left, through which a supply of heated air is passed for its purpose more thoroughly oxidizing the zinc vapour as it leaves the muff.

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 "cathching-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 16 to 34 inches in diameter. By passing the air, 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 zinc, which has been collected, has been collected, has been collected, and is then removed to other bags, and carried to the storing-bins.

It is either sold in a dry state in barrels, holding 200 pounds each, or ground up with linseed oil as a paint, and sent to market in barrels.

THE CIVIL ENGINEER AND ARCHITECT’S JOURNAL.

* From the Special Report of Prof. Wilson, on the New York Industrial Exhibition.
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL.

PRINCIPALS—(Figures 1, 4, and 7). Kilo.
2 Principals of double Y-iron of 0-22m., and together 80-29m. long ....... 794 00
3 Principal and diagonal wrought-iron of 0-040m., being a total length of 60-90m. (Fig. 1) ....... 400 00
4 Cast-iron pillars (Fig. 4) ....... 140 00
3 Cast-iron shoes (Fig. 5 and 7) ....... 180 00
16 Bolts of 0-040m., with heads and threads ..... 38 00
5 Flat wrought-iron struts of 0-075 x 0-015, and each 0-75m. long, and strengthened at each end ....... 40 00
4 Connection-plates of 0-45m. long by 0-2m. broad, and 0-01m. deep at the junction of the principals (Fig. 4) ....... 20 00
16 Connection-plates of 0-60 x 0-24 x 0-34 at the connection of tie-rods and pillars (Fig. 4) ....... 64 00
4 Plates at the connection of the pillars and principals 1m. long, 0-18m. wide, and 0-011m. thick (Fig. 4) ....... 32 00
For securing the same, 20 bolts of 0-16m. diameter, with heads and hexagonal nuts ....... 1678 00
Total kilograms ..... 4655 50
Seven such compartments and connected rafters, &c. weight 23260 50

WEIGHT OF A COMPARTMENT WITHOUT SKYLIGHT.
18 Rafter and ridge plates of double Y-iron, the rafters in lengths of 15-20m., and the iron 0-01m. thick, and with the necessary bolts ..... 2612 00
Total weight of a compartment of the roof ..... 4188 00
Total weight of two compartments ..... 8376 00

DETAILS OF A COMPARTMENT WITH SKYLIGHT.
The principal as above ..... 1678 00
16 Rafter, 11-50m., 15 ridge-plates and roof-ridge, with 15 cast-iron pillars or supports of 10-02 kil. (Fig. 5); 5 Y-irons, to repel the rafters and carry the skylight-framing 109-65 kil.); 24 glass frames, each 4-16 m. long (375-50 kil.); top ridge-plate ..... 2892 50
Total kilograms ..... 4655 50

GLAZING.
7 Glazed compartments, of 60 square metres superfiels, or 850 square metres of glass drainage, total weight of the roof, including the cast-iron shoes, but without the smaller gutters ..... 84295 50
This for 1585-50m. of roof surface and 1501-50 m. of rain covered surface, gives a sectional weight per square metre of roof surface of ..... 40 50
Ditto per metre of roof surface in kilograms ..... 42 50

D. M. LEONIDE MARQUET, of Paris, Architect.

WAREHOUSE OF "LA PROVIDENCE IRONWORKS COMPANY," PARIS.

(With an Engraving and Details, Plate XXXIX.)*

The "La Providence Ironworks Company" has a large depot 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 products according to lengthwise, and 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. A. Girstmeir, author of "La Construction Metalique," 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 wrought-iron Y-iron, which are connected together by a system of tie-bars, to prevent the warping 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 pillars of ashlar, as will be observed on the Plan view. On these pillars they are carried by cast-iron shoes (Fig. 1, 4 and 7). The principals are otherwise completely independent of the masonry, so as to allow of the future addition 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. 125.
The Civil Engineer and Architect's Journal.

IMPROVED TWO-WHEEL CARRIAGES.

P. A. Cottam, Patentee, April 7, 1864.

(With Engravings, Plate XIII.)

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 otherwise one to one from each other at the end, and by interposing between them, near to the open end, one or more separating blocks or stops, so that one of the two pieces being secured as its end to the axle, and the load being placed upon, or suspended from, or attached to the end of one of the other pieces without motion (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, so as to dispense with any separating blocks or stops, and yet produce the action above described.

Thirdly, 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 to the axle, by fixing the imprisoned two above set flexible to the axle, so as to make the carriage to be turned in the narrowest limit, and the line of draught to be shortened to the least possible of the horse.

The manner in which the improvements may be respectively performed is as follows—In fig. 1 (Plate XII.), the side and plan view shows the improved double or compound shaft constructed of two separate pieces A and B, of any suitable description of wood, such as larch, ash, or red pine, and connected together by an iron protung band or strap e. The upper piece A is the entire length of the shaft, and the lower piece B, about 15 or 16 inches in length. 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 larch, 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 3 inches at one end to 2 inches at the other end, and of an uniform width of 33/4 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 thin parts, beginning at the third part, and continuing it till within about 15 or 16 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 15 inches above the head end; and fig. 3 is a similar view, representing the end stretched open a little. In the latter figure e, 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 axles to be divided into three parts, the middle division of which is about 2 ft. 1 or 2 in. in length. The lower piece 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 flat iron, 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 placing the block from one pair of holes to another. Thus, if the weight were small, the block should be placed in the lowest pair of holes; and if very slight in the holes 4, 4. It is to be noted, that from the double end of the shaft for about 18 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 strips to these parts as necessary.

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 other shaft by blocks being kept from each other by springs. When the 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 breaks at the fulcrum, the carriage would fall; but if the wood from c to e, and from b to f, is sufficiently strong to render that contingency impossible, and if the wood from e to c, and from f to b is sufficiently strong 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 e, and from b to f, retains its rigidity or inflexibility, the wood from c to e is bowed out, and the result is a downward and inward motion of the body of the carriage, 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 transoms 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 a; this transom supports or carries the weight of the body of the carriage, on which 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 in the way which places the horse 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 axles and wheels, and a pair of the improved double-spring shafts, together with a transom s, and the transoms frame, the shafts being supported on both to the axles and to the transoms 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 movable, or more correctly speaking, a hinged joint, as it is important that it should not be rigidly connected.

In order to keep the upper carriage or body from swaying about against the rails 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 versa, 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 4, 4, fig. 8, which are essential to the easy action of the carriage when the horse is moving. The weight is placed on the under-carriage beneath the lower portion of each shaft, and over a projecting arm or portion of the transoms 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 they are used 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 crosspoises, and two blocks. The seating of the carriage and the disposition of the weights to be carried upon the carriage are to be such as to be carried upon the carriage in a 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 two rear corner seats of the carriage, which, for convenience, are made so as to let down and hang as flaps when not required, and be used when necessary to afford shelter for the conpassants 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 to 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.
THE CIVIL ENGINEER AND ARCHITECT'S JOURNAL. 463

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 25th May 1856 for the President's Reception Dinner.

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 three forms, appearance of the former gases, substance at the temperature at which they become 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, unless the air was admitted in sufficient proportion, gave off volatiles, for example, 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 such ashes as was composed, and amidst the ash, in minute subdivision, was held in suspension, giving to the smoke its said 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. Southall, 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. For this reason, it is essential that the various gases, when given off more rapidly than their combustion could be supported by the quantity of oxygen passing through the fires in the same period of time; this evil being much aggravated by the heat of the air as usually supplied as ash-pit, generally ranging from 200° to 300° Fahr., 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 fires, and by admitting 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 coal used in this desirable and an attempt 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, and passing immediately above the bright flames. 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 part 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, unless the fire was without a sufficient amount of strong cinders 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 grate into the ash-pit, theme 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 front to back, 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 passage through a long range of grate-bars, the gases, when passing through, gave off volatiles 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 pieces, the larger of which, from below, was smaller, and 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 the complete bridge. The two burned entirely outside of this chamber, and thus established a communication between the interior and the outer air.

The back wall or plate, both of the upper and the lower part of this chamber, or bridge, being perforated with numerous holes, opening to 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 the passage, rendered the flue the throat of the entire furnace, 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 was passed through the grate bars, 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 flames.

Nov. 21.—The discussion being renewed on Mr. Woodcock's paper, it was shown, that although critically precise experiments for determining the rate 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 legislators, a pecuniary saving could be effected. However, by experiments on a cylindrical boiler 17 feet long by 3 feet diameter, it had been shown, that 8½ lbs. of water injected at 42° Fahr. was evaporated by 1 lb. of Newcastle small coal, when Mr. Woodcock's apparatus was in use. It was found, that with small buminous coal, a better evaporation was maintained than when Langennoch 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 pressure of the air kept the original characteristics.

As soon as the valves of the apparatus at Messrs. Mauns 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 were not without a certain advantage for heating the air, prior to its mingling with the gases. Messrs. Mauns 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 stacks could be used, and as it could be purchased at fourteen shillings per ton, whilst Langennoch coal cost twenty-eight shillings, there must be a money-saving and the boilers worked quite as efficiently.

As to the general similarity 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; whilst the latter contended for the advantages 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-pit; and hence to 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 j head tool, and therefore the introduction of hot air would not be inconvenient, 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 in the process. This chilling effect of the air was, however, precisely the case with the gases; whereas this effect was not perceived when the air was admitted at a certain temperature. Under Mr. Williams's system, this has been attempted to be provided against by multiplying the number and diminishing the individual particles of the entering 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, has been
very extensively employed for many years, in conjunction with the
hollow bridge, originally introduced by Mr. Farcy, the father of the late
Mr. John Farcy (M. Inst. C.E.). In corroboration of these views, it was
stated, that on board one of the “Citizens” steam-boats on the Thames,
by a free admission of the air, a great improvement in the working of the
gauze screens in the fire-door, so as to distribute it in minute jets, the
exhibition of opaque smoke was prevented, whilst a saving of fuel
was effected, without any loss of speed, or any extra labour to the stoker.
A dwell boiler, and a blast-pipe being extended from the base of the
funnel, and opening into the bridge, further beneficial effect had
been produced.

This idea was developed into a hollow cast-iron bridge plate, with a series
of various ribs, so arranged as to form tubes, leading up from the aperture
to the apex of the bridge, where the air mingled with the heated gases,
and passed away in flame. The currents of air thus moved were then directed
by a flue in connection with the hollow bridge.

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 the cold air—would purify 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 incan-
descence of the fuel on the bars. This, it was contended, was virtually
accomplished through the side tubes of Mr. Woodcock’s apparatus; as it
might enable the regulation of the quantity of oxygen admitted to the
bar, 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 boilers for, if both were
restricted, so as to demand an excessively rapid draught, there would 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 18th 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 “De-
scription and Drawings of Dipping and Apparatus for Sunk Reefs
and Pier-Head Rooms.”—The Society’s Gold Medal, valued Ten
Scots Pounds.

2. To James Elliot, Teacher of Mathematics, Edinburgh,—for his
“Mechanical Illustrations of the Planetary Movements,” including an
Illustration of the Theory of the Stability of Equilibrium of Saturn’s
Ring and Jupiter’s Iron Mill.—The Society’s Silver Medal, valued Ten
Scots Pounds.

3. To Robert Henry Bow, C.E., Edinburgh,—for his “Description of
New Designs for Iron Roofs of great clear space,” &c.; with Drawings.—
The Society’s Silver Medal, valued Ten Scots Pounds.

4. To William Swan, F.R.S.E., Teacher of Mathematics, Edinburgh,—
for Description of his “Simple Variation Compass.”—The Society’s
Silver Medal, valued Five Scots Pounds.

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, valued Five
Scots Pounds.

6. To George Mitchell, 101, High-street, Edinburgh,—for his De-
scription of a “Safe Lock, incapable of being opened by any other
means than by its own key.”—The Society’s Silver Medal, valued Five
Scots Pounds.

7. To the Rev. James Brodie, Montrose, Fifes,—for his “Enquiry
into the principles on which the action of Sails and Radders 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
Landing Light,” for the Thames.—The Society’s Silver Medal.

9. To Thomas Rodger, jun., St. Andrews,—for his paper “On Col-
olution Calotypes,” with Illustrative Specimens.—The Society’s Silver
Medal.

10. To Alexander Melville Bell, Teacher of Eloquence, Edinburgh,—
for his Paper on a “New Principle of Stereography or Short-hand
Writing.”—The Society’s Silver Medal.

11. To James Young, Blairno, Benziebuy, Lasswade,—for his De-
scription of a “New Method of Shilling Doors,” with a Model—
The Society’s Silver Medal. The Committee have also recommended
the Model to be purchased for the Museum.